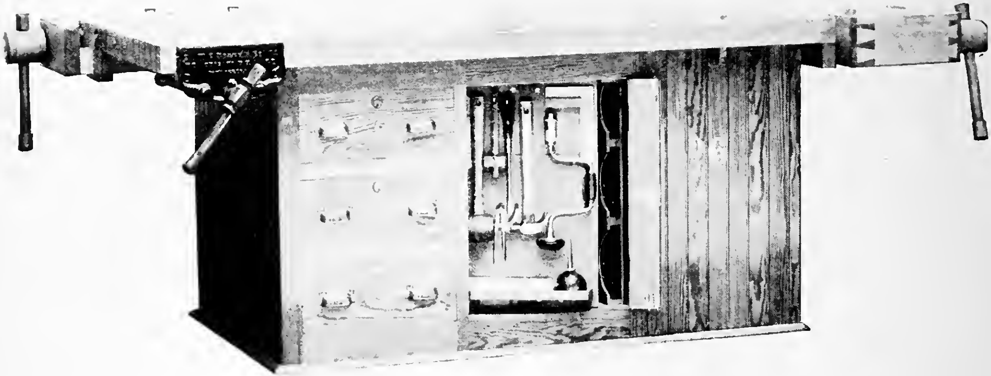
WOODWORK

SAMUEL E. RITCHEY



Designed by S. E. Ritchey, 1893 *Frontispiece*

High School Manual Training Course

IN

WOODWORK

INCLUDING

COST OF EQUIPMENT AND SUPPLIES

AND

STUDIES ON TREES AND WOOD

PREPARED BY

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PREFACE

This course, in its entirety, has been in daily use for nearly three years in the Richard T. Crane Manual Training High School, Chicago. The greater part of it has been in use many years longer. It is the result of an experience of nearly fifteen years in high school manual training work.

It was prepared originally to save time spent by a pupil in writing in his shop note book the many helpful points suggested by his instructor. Such facts, and even the demonstrations, ought to be at the pupil's disposal for future reference, since young people cannot grasp fully even very slow and careful explanations and demonstrations involving the use of unfamiliar tools and appliances.

The description of the equipment and prices and supplies was added to become a part of the boy's wider knowledge of his shop, and in the hope that the items may be helpful to other instructors or schools contemplating manual training.

The short studies on trees and wood are supplemented by lectures on wood, given in the assembly hall, and illustrated by two hundred lantern slides, the property of the school. These lectures take up the preservation of forests, the effect of forests on rainfall and climate, on floods and drought, tree planting, lumbering, milling, transporting, seasoning.

W. P. 1

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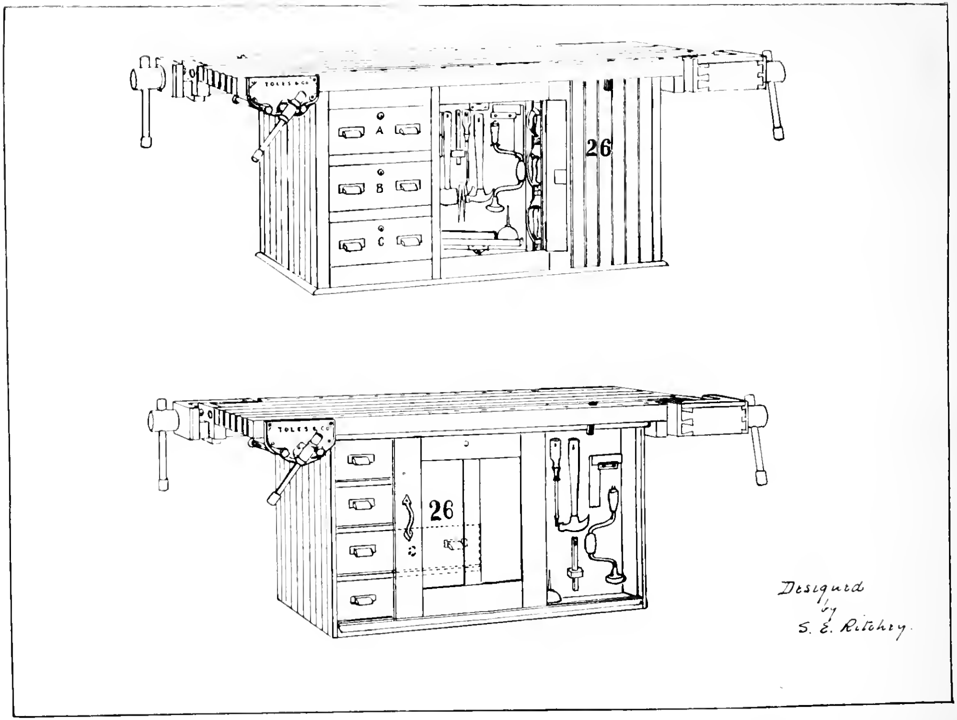


Fig. 1

EQUIPMENT

MANUAL TRAINING BENCHES

Two styles of double benches are shown (Fig. 1). Thirty-six benches of the first style have been in use for several years at the R. T. Crane School—the English High and Manual—and have given perfect satisfaction. The cost was $40.00 each, including two Tole's vises.

The tops are glued up of alternate strips of hard maple and cherry, or hard maple and walnut, and each is supplied with a Tole's vise and a tail-screw vise on each side.

The cupboard door swings on L shaped pivots, in the center, at the ends, and when open displays the "general" tools conveniently in sight, and still back in the cupboard far enough to prevent striking the knees.

Three deep, slender pockets, to the right of the door, hold the three saws. There is room back of the door for two plane stocks, the bench brush, and the bench hook. The three drawers are roomy and deep, as deep as the width of the base of the bench.

In the second style of bench a sliding door covers the cupboard for the "general" tools. This style of bench has somewhat more drawer room, since the loss in depth, taken off for the cupboard, is more than made up by gain in width.

Three deep pockets, between the drawers and cupboards—as in the other bench—serve to hold the saws.

WOOD SHOP OUTFIT

Each bench is outfitted with two sets of "general" tools, for the use of every boy who works at the bench, and six sets (the lower bench eight sets) of "individual" edged tools, each set for the use of one particular boy only, for the whole year.

The keeping of these tools in perfect condition, especially the individual, edged tools, is one of the chief features of the boys' manual training.

The general tools, with retail prices, are:

1—No. 3 Bailey iron plane stock, 1¾″ bit	$1.10	
1—No. 5 Bailey iron plane stock, 2″ bit	1.35	
1—6″ Stanley iron handled try square	.24	
1—8″ swing Barber's brace, ball bearing	1.08	
1—12 oz. Maydole riveting, or claw hammer	.55	
1—Rubber mallet	.75	
1—6″ Tower champion screw driver	.35	
1—Box-wood marking gauge	.28	
1—Stanley 6″ T bevel	.40	
1—6″ Bemis & Call dividers	.32	
1—All bristle bench brush	.60	
1—Lily-white Washita oil stone, fine, 6″x2″x1″	.45	
1—Oil can	.18	
1—10″ back saw	.94	
1—20″ cross-cut saw	1.40	
1—22″ rip saw	1.40	
	——	$11.39

The individual tools, with retail prices, are:

1—1″ Buck Bros. beveled edge, handled firmer chisel	$ .57	
1—½″ same	.46	
1—¼″ same	.41	
1—double iron for No. 3 Bailey plane, 1¾″ bit	.38	
1—double iron for No. 5 Bailey plane, 2″ bit	.42	
	——	$2 24

Note.—Above prices are retail prices, for use of pupils who wish to buy tools. A discount will of course be given when tools are bought in sets.

The No. 3 Bailey plane, complete, retails at	$1.35	
The No. 5 Bailey plane, complete, retails at	1.70	
	——	$3.05

WOOD SHOP MACHINERY AND MOTORS

1—24″ Clements single surfacer	$300.00	
1—Beach scroll saw	80.00	
2—36″ Clements band saws	260.00	
1—Boring machine	90.00	
1—Oliver circular saw	300.00	
4—Brown & Sharpe grindstones with truing devices	360.00	
1—Glue heater—steam	15.00	
1—Fox trimmer	80.00	
1—Hand planer (jointer)	150.00	
1—Dry emery grinder	40.00	
1—Automatic planer knife grinder	112.00	
1—Turning lathe—10″—lecture room	50.00	
1—Sturtevant shaving exhauster, 40″, with Willmareth & Rabbe shaving separator and piping	900.00	
1—30 H. P. motor, wiring and starting box	500.00	
1—20 H. P. motor, wiring and starting box	400.00	
1—2 H. P. motor, wiring and starting box	250.00	
Shafting, hangers, belting, pulleys	600.00	
	——	$1,487.00

TURNING SHOP OUTFIT

30 Lathes, 10″:

Reed lathes, with 2 bearings for headstock spindle	each	$50.00	
Prentice lathes	each	50.00	
Wetherby, Rugg & Richardson lathes	each	60.00	
		——	$1,580.00
30 Tool cases—5 drawers	each	23.00—	$690.00

The general tools, in tool drawer, with prices, are:

1—Firm joint calipers, 6″, outside	$ .50	
1—Firm joint calipers, 6″, inside	.50	
1—Lily-white Washita oil stone, fine, 6″x2″x1″	.50	
1—Lily-white Washita oil slip stone, fine	.15	
1—Oil can	.18	
1—Screw driver	.35	
1—All bristle bench brush	.60	
1—6″ swing Barber's brace, ball bearing	.95	
1—6″ Bemis & Call dividers	.32	
1—⅛″ German gimlet bit	.10	
1—¼″ same	.10	
	——	$4.25

The general turning chisels, with prices, are:

1—1″ Buck Bros. handled skew chisel	$ .64	
1—½″ same	.34	
1—¾″ Buck Bros. handled turning gouge	.63	
1—⅜″ same	.47	
1—¾″ Buck Bros. handled square scraping chisel	.56	
1—⅜″ Buck Bros. round nose handled scraping chisel	.45	
1—¼″ same	.42	
1—⅜″ Buck Bros. handled spearpoint scraping chisel	.45	
	——	$3.96

The individual turning chisels in each drawer, with prices, are:

1—½″ Buck Bros. handled skew chisel........	$ .42	
1—¼″ Buck Bros. handled square scraping chisel	.42	
		$0.84

Note.—It is hoped that each boy will have most of these cutting tools as his own individual tools in the near future.

MACHINERY AND MOTORS

1—Leland & Faulconer water emery grinder	$100.00	
4—Grindstones and truing devices........	200.00	
1—30″ Clements band saw...............	100.00	
1—10″ turning lathe—lecture room........	50.00	
1—25 H. P. motor, wiring and starting box.	400.00	
1—2 H. P. motor, wiring and starting box..	250.00	
Shafting, hangers, clutches, pulleys, belting.	800.00	
		$1,900.00

TOOL ROOM EQUIPMENT FOR 72 PUPILS

Clamps and Handscrews

2 steel bar carpenter's clamps—open 6 ft....	$7.00	
1 doz. steel bar carpenter's clamps—open 2½ ft.	17.00	
4 doz. Bliss handscrews, 9″ jaw	12.50	
4 doz. Bliss handscrews, 14″ jaw	15.00	
1 doz. each clamp and set screws for Bliss handscrews—9″ jaw.................. } 1 doz. each clamp and set screws for Bliss handscrews—14″ jaw................ }	5.00	
		$56.50

Rules

2 doz. 2 fold pattern maker's rules, 24¼″.....	$12.00	
½ doz. 2 ft. rules, unbound	1.20	
		$13.20

Bits

1 complete set Russell Jennings brace bits in box............................	$4.00	
½ doz. ¼″ dowel bits—Russell Jennings, 4½″ long twist..........................	.95	
½ doz. ⅜″ dowel bits—Russell Jennings, 4½″ long twist..........................	1.40	
2 sets each, Pratt's German gimlet bits, 2-32, 3-32, 4-32, 5-32, 6-32 and ¼...........	.85	
1 each No. 1 and No. 2 expansion bits.......	1.75	
½ doz. rose countersinks...................	1.00	
		$9.95

Files

1 doz. 10″ mill bastard, one round edge......	$2.00	
1 doz. 7″ slim taper	1.40	
1 doz. 4″ slim taper	.85	
1 doz. 8″ half round, mill bastard	2.20	
		$6.45

Wrenches, Pliers

1 each—6″, 10″, 12″, 18″ Coe's monkey wrenches, black.......................	$2.35	
½ doz. S wrenches, assorted................	1.00	
1 pipe wrench, 12″........................	1.50	
1 Osborn gas pliers, 10″...................	.75	
1 Barnard's cutting pliers..................	.90	
2 flat nosed pliers........................	.40	
½ doz. carpenter's pinchers—8″.............	1.20	
		$8.10

Belt Repairing

1 complete wire lacing outfit................	$10.00	
25 ft. each ¼″ and 5-16″ rawhide belt lacing..	.40	
200 each 1″, 1½″ and 2″ pointed belt hooks..	1.25	
5 gals. belt grease........................	6.00	
1 belt punch, 4 cutters	.90	
		$18.55

Repairs for Planes

$\frac{1}{2}$ doz. handles for each No. 3 and No. 5 Bailey planes	$1.00	
$\frac{1}{2}$ doz. caps, with cap screws, for each No. 3 and No. 5 Bailey planes	2.50	
2 frogs, with screws and washers, for each No. 3 and No. 5 Bailey planes	1 30	
		$1.80

Ladders

2—12 ft. ladders, strong, wide at base, with steel points	$4 50	
2—8 ft. step-ladders, strong, braced	5 00	
		$9.50

Miscellaneous

1 set steel letters, 5-16″	$1 50	
1 set steel figures, $\frac{1}{4}$″	.50	
1 50 ft. tape line, linen, wired	2 50	
1 12″ level, Stanley	90	
$\frac{1}{2}$ doz. steel carpenter's squares	4 50	
1 each Champion screw drivers, 3″, 12″, 18″	1 60	
$\frac{1}{2}$ doz. Pratt's knurled, cup point nail sets, 3-32″	.50	
1 doz. assorted brad-awls, handled	60	
4 tin lined glue pots, 1 qt	2 00	
2 each $\frac{1}{8}$″, $\frac{1}{4}$″, $\frac{3}{8}$″, 19 ft. band saws, filed and set	10 00	
1 doz. felloe webs, heavy (scroll saw blades)	1 25	
1 doz. each 2″ and 3″ middle brass butts	1.30	
1 ratchet brace, 10″ swing, ball bearing	1.50	
50 each, $\frac{1}{4}$″, $\frac{3}{8}$″, $\frac{1}{2}$″ dowel rods	1 00	
1 doz. each, $\frac{1}{4}$″, $\frac{3}{8}$″, $\frac{1}{2}$″, $\frac{3}{4}$″, 1″ Buck Bros. handled paring gouges	27 50	
$\frac{1}{2}$ doz. each, $\frac{1}{4}$″, $\frac{1}{2}$″, 1″ Buck Bros. handled firmer gouges	$7.50	
$\frac{1}{2}$ doz. steel cabinet scrapers	.50	
2 doz. Stanley iron handled spoke shaves, adjustable	5.00	
1 doz. wood handled spoke shaves	2.00	
$\frac{1}{2}$ doz. pattern maker's knives	4.50	
1 Star hack saw, and 12 blades for same	2.65	
25 ft., $\frac{3}{4}$″ hemp rope	2.00	
		$81.30

SUPPLIES FOR ONE YEAR FOR 72 PUPILS

Lumber

500 ft. 1″ first clear white pine, kiln dried, s2s to $\frac{7}{8}$″, $75.00 M	$37.50	
500 ft. 2″ first clear white pine, kiln dried, s2s to $1\frac{3}{4}$″	37.50	
250 ft. $1\frac{1}{4}$″ first clear white pine, re-sawed, then kiln dried, s2s to $\frac{1}{2}$″	19.50	
500 ft. 1″ first clear yellow poplar, kiln dried, s2s to $\frac{7}{8}$″, $45.00 M	22.50	
1000 ft. 2″ first clear gum, rough, ripped into strips, 2″ wide, $35.00 M	35.00	
200 ft. first clear red sycamore, kiln dried, quarter sawed, $65.00 M	13 00	
200 ft. 1″ first clear red sycamore, kiln dried—Q. S. re-sawed	14.00	
200 ft. 1″ first clear white oak, kiln dried, quarter sawed, $65.00 M	13.00	
200 ft. 2″ first clear red sycamore, kiln dried	13.00	
200 ft. 2″ first clear white oak, kiln dried	13 00	
		$218.00

Brushes

½ doz. ⅝″ iron handled glue brushes	$ .65	
½ doz. 2″ chiseled Fitch flowing varnish brushes	1.40	
½ doz.—1″ chiseled Fitch flowing varnish brushes	.75	
½ doz. 2 quill, split-quill pencils, pointed	.60	
1 doz. No. 5 artists' round bristle	.35	
1 doz. No. 4 artists' round camel's hair	.35	
		$ 4.10

Varnish, Oils, Sandpaper, etc.

3 gals. best piano finish copal rubbing varnish	$ 6.00	
5 gals. double extra pure grain alcohol white shellac varnish	15.00	
3 gals. turpentine	1.95	
5 gals. grain alcohol	10.75	
2 gals. raw linseed oil	.80	
1 gal. boiled linseed oil	.45	
5 lbs. orange shellac, dry	1.75	
3 lbs. Chinese vermilion	2.00	
5 lbs. pure country bees-wax	1.00	
2 reams No. 1 Beader & Adamson or Union sandpaper, $1.90 ream	3.80	
1 ream each, No. ½, 0, 00, same	5.70	
2 doz. 1½ pt. tin cups	.60	
4—1 gal. glass bottles, with glass stopper	1.50	
2—2 gal. varnish cans, encased in wood	1.50	
1—5 gal. oil can, with pump	1.00	
50 lbs. extra fine powdered pumice stone, 2c. lb.	1.00	
25 lbs. extra fine powdered rotten stone, 4c. lb.	1.00	
1 doz. 1 lb. cans, each white and brown, Wheeler's wood filler, 15c.	3.60	
2 gal. golden oak oil stain, $1.20	2.40	
2 doz. 1 lb. cans Butcher's wax polish, 35c.	8.40	
10 lbs. lamp black, 8c.	$ .80	
¼ bbl. Cooper's 1X glue	7.00	
1 lb. sheep's wool sponges	2.00	
2 yds. saddler's felt (for rubbing pumice)	4.00	
25 lbs. fine cotton batting (to polish)	4.00	
20 yds. fine cheesecloth (to polish and wax)	.80	
		$88.80

Flat-head, Bright Screws

5 gro. each—	1 gro. each—	2 gro. each—	
1¼″ No. 10	2½″ No. 16	¼″ No. 1—2	
1½″ No. 11	3″ No. 16	⅜″ No. 2—5	
1¾″ No. 11	3½″ No. 18	½″ No. 3—6	
2″ No. 12	4″ No. 20	⅝″ No. 4—7	
1¼″ No. 16		¾″ No. 4—7	
		⅞″ No. 6—9	
		1¼″ No. 6	
		1½″ No. 7	
$6.00	$3.20	$2.20	11.40

WIRE BRADS		WIRE NAILS		
5 lbs. 2″ No. 13	$ .25	5 lbs. 3″ No. 10	$ .25	
5 lbs. 1½″ No. 15	.30	5 lbs. 2″ No. 13	.25	
5 lbs. 1″ No. 18	.40	5 lbs. 1½″ No. 14	.30	
2 lbs. ¾″ No. 20	.20	5 lbs. 1″ No. 16	.40	
2 lbs. ½″ No. 20	.20			
	$1.35		$1.20	2.55

LAG BOLTS		MACHINE BOLTS		
25—1½″—5/16″ dia.	$ .17	25—1½″—5/16″ dia.	$ .20	
25—2″—⅜″ dia.	.20	25—2″—⅜″ dia.	.24	
25—3″—⅜″ dia.	.23	25—3″—⅜″ dia.	.26	
	$ .60		$ .70	1.30

TOTAL	$326.15

COST OF COMPLETE WOOD SHOP OUTFIT FOR SEVENTY-TWO BOYS

(Three classes—twenty-four pupils in each)

12 double benches, with Tole's vises and wooden tail screws, 3 drawers and tool cupboard on each side, $50.00 each	$ 600.00	
24 sets general tools, $15.00	360.00	
72 sets individual tools, $2.25	162.00	
1—36″ Clements band saw	130.00	
2—Brown & Sharpe grindstones, with truing devices	180.00	
1—Oliver circular saw	30.00	
1—Glue heater and connections	25.00	
1—15 H. P. motor and starting box	350.00	
Shafting, pulleys, belting, hangers	105.00	
Tool-room outfit	206.00	
Supplies for one year for 72 boys	325.00	
		$2,473.00

COST OF COMPLETE TURNING SHOP OUTFIT FOR SEVENTY-TWO BOYS

(Three classes—twenty-four pupils in each)

24—Wood turning lathes, with countershafts, $50.00	$1,200.00	
Shafting	40.00	
Pulleys	100.00	
Hangers	285.00	
Belting	245.00	
2—Brown & Sharpe grindstones with truing devices	180.00	
1—30″ Clements band saw	90.00	
1—Leland & Fauleoner water emery grinder	100.00	
1—25 H. P. motor with starting box	400.00	
24—tool cases or benches, $25.00	600.00	
24 sets drawer tools, $4.25	106.00	
24 sets general tools, $4.00	100.00	
72 sets individual tools, $ .85	62.50	
1,000 ft.—2″ gum, ripped 2″ wide	36.00	
		$3,544.50

COURSE IN SHOP WORK—FIRST YEAR

TIME

In the wood-shop, the 40 weeks of the school year are divided into 4 equal periods:

10 weeks for carpentry,
10 weeks for wood turning,
10 weeks for cabinet making,
10 weeks for pattern making.

From $1\frac{1}{2}$ hours to 2 hours are given to shop work, every day, for 5 days in the week—the rest of the time is devoted to the usual high school academic work, including 1 hour each day in mechanical, or other, drawing.

A working drawing, to a scale, showing plan, elevation, and end views, and necessary sectional views, with all dimensions, is required from each pupil, before beginning to make any exercise. These drawings are made at home.

TREES

White Pine—Great usefulness of wood—reasons—where found—growth—leaves and fruit—character of wood—cost—use in shop.

Gum—Two kinds—use of each—where found—growth—leaves—coloring—fruit—peculiarities of grain—cost—use in shop.

Tulip Tree, Yellow Poplar—Large growth—usefulness of tree—where found—leaves—flowers—fruit—cost—use in shop.

Oaks—Great general utility in olden times—superseded somewhat by softer woods of America and use of iron—chemical properties—different species—standard of measurement—where found—character and beauty of wood—medullary rays—leaves—fruit—cost—use in shop.

Sycamore—Size of tree—where found—peculiarity of bark—leaves—fruit—interwoven, cross-grain—medullary rays—use in general—cost—use in shop.

Maples—Growth world wide—great utility—leaves—color—winged seeds or "keys"—character of wood—close, hard grain—beauty of bird's-eyes and curls—presence of sugar in sap—general use—cost—use in shop.

Birches—Growth in all northern hemispheres—history very old, probably on account of bark—use of bark in ancient times—in modern times—by American Indians—character of wood—color—beauty of curly birch—cost—general use—use in shop.

WOOD

Talks on wood—Structure—different tissues, pith, wood, bark—cambium layer—annual rings—sap wood

—heart wood—food, growth, cutting, moisture—shrinkage—grain of wood—drying—stiffness, products, milling—quarter sawing—measurement—values.

CARPENTRY—TEN WEEKS

Sawing

Talks on saws—Reasons for different amount of pitch on teeth—saw-setting—filing.

Knife lining with square, across the grain—gauging with the grain—sawing to knife line—ripping to gauge line.

Application—Sawing out stock for box.

Grinding

Talks on grinding tools and machines—Sandstone—emery—use of water—speed of stone—direction—truing device.

Grinding plane bits and chisels—Length of bevel or grind for hand tools, while cutting wood—stone, iron.

Sharpening

Oil stones—Use of oil.

Whetting straight tools—Plane bits and chisels—on oil stone—gouges on oil slips.

Planing

Talks on planes—Smooth, jack, jointer, rabbet—different planes for different trades.

Cover or breaker—Reason for use—difference in setting—illustrations—setting the plane-bit.

To plane a true surface—Pressure applied at toe and heel.

To joint edges—Making straight and square—use of try square.

To plane ends square—Reversing direction of plane.

Practice in Gauging

To plane to dimensions—Rule for planing to dimensions.

To plane to gauge lines—Sharpening gauge point—light and heavy gauge lines affecting dimensions.

Nails

Talks on nails—Wire and cut—sharp and blunt ends—parallel and wedge shaped sides.

Talks on construction of barrels, boxes, crates—Suggestions as to best methods of fastening on bottoms and tops.

Application—Making a box of white wood, having given only inside dimensions, and thickness of material—Stock bill to be made by each pupil.

A sawing and planing exercise, in which each piece is to be made exactly to dimensions, nailed together, and inspected by instructor before smoothing off outside surfaces.

Chiseling

Grinding and sharpening of chisels—Length of bevel or grind.

Shearing cuts—To prevent tearing of annual rings—chiseling to knife lines—sides and bottoms of grooves, across and with the grain.

Oblique surfaces—Marking out without knife or gauge.

Making and laying out a complete chiseling exercise—Planing — sawing — knifing — chiseling square grooves, mortises, oblique surfaces—paring with a shearing cut—making of hat-rack strip.

Construction

Talks on carpentry construction—House-framing—roofs—trusses—joints used in such construction.

Application—Making of half lap—mortise and tenon—dovetail — keyed joints — wedged joints — doweled joints.

WOOD TURNING—TEN WEEKS

Talks on the steam engine—Electric motor.

Hangers — Adjustable, ring oiling — Shafting, cold rolled, turned—speed.

Pulleys — Crown and flat-faced — speed. Clutches. Belting—How made, repairing, dressing. Belt lacing—Belt hooks, gluing. Counter shaft—Use, parts, speed.

Talks on loose pulleys, clutches, bushings, methods of oiling and greasing.

The Lathe

Primitive lathe—Hand power. Modern lathes. Free hand drawing of lathe and counter shaft, by pupil—all parts named on drawing. Care of lathe—Oiling—cleaning. Speed of lathe for large and small diameters.

Turning Between Centers

Turning chisels, skews and gouges—Grinding and whetting.

Cylindrical forms—Gouge and skew chisel—gouge held tangent to wood and rolled over to make shearing cut—skew held tangent and at an angle to smooth surface.

Cylinder to dimensions and length—Calipers.

Square and V grooves, holding skew with grind at right angles to wood—use of acute point and obtuse point of small skew illustrated.

Convex and concave curves—Beads and hollows—small gouge rolled over. Combinations and applications—darner, gavel, turned parts of patterns.

Chuck Turning

Scraping tools—Reason for use, grinding and whetting. Face plates—Turning true surfaces and beads and hollows.

Application—Parts of patterns—rosettes, pin-trays.

Wood chucks—Reversing exercise—segment work.

Application—Ring, pulleys, sphere.

CABINET MAKING—TEN WEEKS

Talks on cabinet woods—Beauty of grain—quarter sawing—seasoning—kiln drying.

Clamps—Hand screws—hand clamps—wedge clamps—presses—vises.

Talks on glue—Cooking—glue pots—heating ovens for wood and glue—glue-joints—doweled—tongued and grooved—clamped—rubbed joints—end wood joints—sizing.

Preparing beautiful cross-grained and curly grained wood for varnish or finishing—The cabinet scraper—filing and oilstoning—scraper steel—sharpening.

Sandpaper—How made and sold—care in using.

Finishing (Varnishing)

Preparing for varnish—Use of shellac varnish to hold color of wood—linseed-oil fillers, use of, saving—stains, oil, water, alcohol.

Varnishes

Talks on preservatives of wood—Shellac varnish—composition—uses—durability.

Copal varnish—Composition — uses — thinning — durability.

Rubbing Down

Pumice stone—Use—composition—methods of rubbing.

Patching

Oiling—Staining—revarnishing.

Polishing

Rotten stone—Composition—methods of using.

Waxing

Old time methods of finishing wood.

Preparing wood with filler or shellac varnish before waxing.

Cracking and Blistering

Supposed causes—Helps.

Application — Glove box — taboret — letter box —hand mirror — French stool — hat frame — mirror frame—magazine holder.

PATTERN MAKING—TEN WEEKS

Talks on Foundry—Cupola.

Methods of molding—Casting, flask, cope and drag, venting.

Making of drawing of flask, showing pattern rammed up in position—Sprue, riser, vents.

Parting—Parted patterns—coping down.

Ramming up solid and parted patterns.

Coring and cores, green sand and baked—Core ovens, venting.

Green sand molds; core sand molds.

Three or more part flasks—Patterns with movable parts.

Draft, finish, shrinkage allowances, shrink rule—Pattern for block of iron.

Patterns with movable parts—Shifting fork, gibbed slide.

Patterns leaving their own core—Hexagonal wrench, brass bushing, turnbuckle.

Core-prints, tight and loose, with much draft when vertical.

Core-boxes, semi-circular.

Patterns with baked cores—Tool post, face plate.

Segment work—Face plate, pulleys.

Diagonal parting of patterns, use.

Special coring—Recess cored block.

Molding in cores—Special pattern for chain.

Pipe connections—Patterns having same centers—tee and elbow.

Return bend—Double patterns.

NOTE.—Experience has shown that in Carpentry, the making of the box and of three or four joints is the limit of work for the average pupil, for ten weeks. If the book rack is substituted, the book rack, two joints, and the hat rack strip can be made.

In Cabinet Making, a glove box and a taboret or small table require all the efforts of the better pupils for the ten weeks. A glove box and a hand mirror, or a hand mirror and hat frame or magazine holder are suggested as simpler projects.

In the R. T. Crane School two cabinet making exercises are required from each pupil, one of which is left at the school, the other taken home. No charge is made for the wood.

In Wood Turning, the two exercises between centers, a turned handle for wrench in pattern work, also the tool-post, or bushing, or face-plate pattern, and a rosette or chucking exercise are a full ten weeks' work for the average boy. The better pupils can turn the stocking darner and the inkstand or hand mirror or the four legs for small table in addition.

In Pattern Making the rectangular block, in which allowance is made for finish, shrinkage and draft, and four other patterns, two at least with core boxes, are required.

In all the school work careful explanations are made regarding the construction of such carpentry, cabinet work and pattern work, in the shop course, that is not made by any particular class. The suggestion is made that different classes take up somewhat different work, and that all classes profit by careful explanations of the others' work, or, one class may cover the whole course —in pattern making, for instance—by having the many exercises divided among the members of that one class.

The different subjects in the course need not be taught in the order named. Carpentry must precede cabinet work, though turning may come between, or first on the list. Pattern work is left to the last ten weeks, that the pupil may have the better use of all his faculties in that subject, which requires so much care, thoughtfulness and accurate work.

White Pine

(*Leaves indeterminate*)

The white pine (Fig. 2) is probably the most useful of all northern trees, and was formerly very plentiful; one third of all the sawed lumber and timber was white pine, but it is now unobtainable in many places. Because of its light weight, easy working qualities, the large and perfect pieces, pine is more used in carpentry and construction than other woods.

FIG. 2.—Leaves and Cone of White Pine

White pine grows in the northern and northeastern United States, northward into Canada, and along the Alleghany Mountains.

The tree grows erect and straight—75 to 150 ft. high, and from 2 to 4 ft. in diameter—free from limbs to a great height.

The leaves are in fives, slender and soft, evergreen, from 3 to 5 ins. long, in a loose, short sheath. The cones are slightly curved, and are 4 to 6 ins. long, and 1 in. thick.

The heart wood is cream white; the sap wood is nearly white—close, straight grained, free from knots and resin. White pine is easily worked, being soft, uniform, light and clean; it seasons well, and shrinks less than other pines.

The wood is used for matches and spars, and in carpentry and construction more than any other wood.

First, clear white pine (best quality) costs from $80 to $100 per M (1,000 sq. ft.).

Stumpage (short, 4-ft. lengths), clear, costs only half.

Seconds and poorer grades—knotty—cost from $30 to $40 per M.

White pine is used in the wood shop principally for pattern making. It is the best wood known for that purpose, as it is easily worked and holds its shape.

Gum

(Leaves alternate)

Sweet Gum or Red Gum (Fig. 3), and Sour Gum or Black Gum (Fig. 4), are unrelated trees, the sweet or red gum being a witch-hazel and the sour or black gum

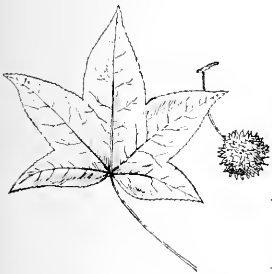


Fig. 3.—Leaf and Fruit of Sweet Gum

Fig. 4.—Sour Gum

a dog-wood. The trees are distinct from each other, but both are called gum. The softer sweet gum resembles walnut, and is used in place of that wood for furniture and veneers. Sour gum is harder and lighter in color, splits with difficulty and is used in turnings and small work. Both woods are cross-grained, close and strong, tough and difficult to season.

The sweet gum tree has rough, round balls or seed pods, like the sycamore, but covered with somewhat sharp points. The leaves are pointed and starlike, like those of the maple. The tree is called liquid-amber, because of the gums excreted and used in medicine.

The sour gum (Fig. 4) has bluish black, sour drupes, or fruit, with a single seed, and thick, oval leaves from 2 to 4 ins. long. The leaves of both species turn to brilliant scarlet or crimson in the autumn.

Sweet Gum

Sweet gum grows in eastern United States to the Mississippi River, in Texas and Mexico.

The tree is from 80 to 100 ft. high and from 2 to 4 ft. in diameter; the trunk is tall and straight, the leaves star-shaped, turning to bright scarlet in the autumn; it bears round, rough balls on long stems.

The wood is like walnut, a rich brown color, with nearly white sap wood, close, cross-grained, heavy, soft to work; it shrinks and warps badly in seasoning.

It is used for table legs, wood turning, veneers, wooden plates, and shingles.

Sour Gum (Black Gum)

Sour gum grows in the same localities, but is not so large, and has bluish-black sour fruit with one seed.

The wood is light brown, of fine grain, with interwoven fibers, tough and hard to work because of the cross grains; it checks badly in seasoning.

Gum trees are now used for railroad ties and are giving good service; the wood is used also for wooden ware, rollers, and wagon hubs.

First, clear gum costs from \$35 to \$38 per M. We use gum in the wood shop for turning. It is a beautiful wood, but warps and twists too much for cabinet work.

Tulip Tree

(Yellow Poplar, White Wood—Leaves alternate, edges lobed)

These names are interchangeable, and are applied to a soft, greenish-yellow wood, fine grained, suitable for carvings, wooden ware and boxes, as the wood nails without splitting. Much poplar or white wood is made into lumber and used in cheap furniture for drawer bottoms and shelving; it is used also for carriage bodies.

The tree bears a mass of tulip-shaped flowers in the spring, large and brilliant, yellowish-green in color, partly red; and develops a narrow greenish cone, which remains on the tree all winter.

The tree grows very large and is one of the most useful of the American trees.

The Indians formerly made their dugout canoes from the logs; some were large enough to carry twenty persons.

The Tulip Tree (Fig. 5) grows in United States, east of Mississippi.

It grows from 90 to 150 ft. high, and 5 to 7 ft. in diameter.

The heart wood is light yellow, the sap wood nearly white, straight grained, close, free from knots, soft and light, easily worked and stands well.

It is used for carriage bodies, wooden ware, pumps, boat building, and shingles.

Fig. 5.—Leaf of Tulip Tree

First, clear poplar costs \$45 per M. We use yellow poplar for carpentry work, as it is much cheaper than pine, and can be worked easily.

Oaks

(Leaves alternate, edges lobed)

Oak trees grow in all countries north of the Equator and in high altitudes of those countries just south of the Equator. Oak wood has been much used for hundreds of years, for house and ship building, being plentiful and strong. After the Civil War ships were made of iron, and as the forests of softer woods were opened up, the use of oak was gradually discontinued.

Oak is tough and durable, but is hard to season, as it warps and checks. The medullary rays of all oaks

are very prominent, and when the wood is quarter sawed make beautiful rays or lights.

Oak contains acids, causing stains in the wood. The bark also contains quantities of tannic acid, used to tan leather.

The principal species are White Oak, Red or Black Oak, and Live Oak.

The White Oaks are: White Oak (Fig. 6), Chestnut Oak, Cow Oak, Post Oak, Burr Oak, Pacific Post Oak, Swamp White Oak.

The timber of these trees is the standard when comparing other woods. If we say the strength of white pine is one half, we mean one half that of white oak.

The leaves of white oaks have rounded lobes. The acorns ripen in one season and fall off, and some are sweet, and are much sought after by farm animals, the cow oak of the Southern States being so named because the acorns are eaten by cattle.

The wood of white oak is most used of all very hard woods, so the supply is diminishing.

The Red Oaks (Black Oaks) are: Red Oak (Fig. 7), Pin Oak, Spanish Oak, Yellow Oak, and Scarlet Oak, These trees are larger than the white oaks, and have a smoother and darker bark.

The leaves have sharp, pointed lobes, the acorns are large and bitter, and are easily recognized by their shallow cups.

The acorns of some of the red oaks remain on the tree through the first winter, and ripen and fall the second summer.

The acorns of the yellow and scarlet oaks are smaller, with deeper cups.

The wood is light brown or red, to pink.

The Live Oaks are: Live Oak (Virginiana), California Live Oak, and Live Oak (Canyon).

Live oaks (Fig. 8) grow in the South and Southwest, and California, and are not so large.

The leaves of the live oaks have no indentations, excepting those of the California live oaks, which are spiked like those of the holly.

The leaves are evergreen, remaining on the tree all winter.

The acorns ripen in one season.

The wood is very heavy, one cubic foot weighing nearly 60 lbs., and is strong and very durable, and is used for ship building.

The annual layers are hardly seen.

White Oak

White Oak grows in northern and eastern United States. The tree is 60 to 90 ft. high and 3 to 5 ft. in diameter, with a gray bark and sweet, oblong acorns in rough cups, and rounded projections or lobes on leaves.

The heart wood is brown in color, with whiter sap wood, annual layers marked, and medullary rays large and beautiful.

The wood is liable to check unless seasoned slowly, is hard and heavy, tough and strong, most durable and elastic—so elastic that when steamed it may be bent to almost any shape.

White oak piles of old London Bridge, taken up in 1827, after six and one-half centuries of use, were found sound. Oak under water or under ground does not change much.

It is used for cabinet making, interior finishing, railway car construction, cooperage, ship building. The bark contains tannin, used in tanning leather. Because of the value of the timber and also because the acorns are eaten by animals, the white oak supply is diminishing.

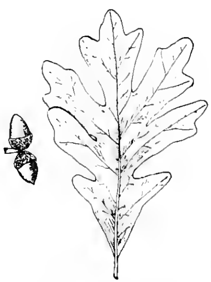


Fig. 6.—White Oak Leaf and Acorns

Fig. 7.—Red Oak Leaf and Acorn

Cow oak is used in the South for agricultural implements and wheels. The acorns are fed to cattle.

Chestnut oak is used principally for railway ties as it is most durable in contact with the soil.

The leaves are like those of the chestnut.

Post oak and Iron oak are used principally for railway ties and fencing.

Burr oak, Over Cup oak, Mossy Cup oak have a mossy fringed border at the top of acorn cup.

Red Oak

Red oak grows east of the Rocky Mountains.

The tree is 90 to 100 ft. high, and 3 to 5 ft. in diameter; brown bark; the leaves have sharp, pointed projections; the acorns are very large, in shallow cups.

The heart wood has a reddish tinge; the sap wood is dark; the annual rings are marked, medullary rays large, and the wood so coarse grained and porous as to unfit it for staves for large casks; but it is heavy and strong.

It is used for furniture, and interior finish.

Red oak grows faster than other oaks, and the bark has more acid for tanning.

Pin oak, Swamp oak, Water oak grow in moist places, and have many little secondary branches like pins, and are easily distinguished.

Spanish oak grows in the South; the bark is very rich in tannin.

Black oak or Yellow oak grows very large, has bitter yellow acorns, and the yellow inner bark is used for making a yellow dye.

Live Oak

Live oak grows in the Southern States, Cuba, Central America, Mexico and California. The tree resembles

the apple tree and is only 45 to 60 ft. high and 2 to 4 ft. in diameter. The foliage is evergreen.

The heart wood is yellow or brown, the annual layers can hardly be seen, the medullary rays are large, and the wood is strong, tough and very durable.

It is used for ship building, especially for knees and crooked timbers, as the tree does not grow tall or straight.

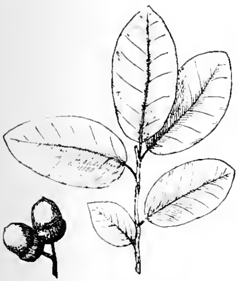


FIG. 8.—Live Oak Leaf and Acorns

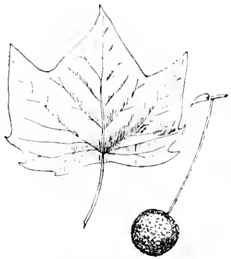


FIG. 9.—Sycamore Leaf and Fruit

Before steel and iron came into use for ship building, live oak was the wood chiefly used for that purpose. The American government bought great tracts of land, containing live oaks, so that the U. S. navy should have the necessary timber with which to build ships.

First, clear oak, quarter sawed, costs $75 per M. We use oak in the wood shop for cabinet making.

Sycamore (Button-wood, Button-ball)

(Leaves alternate, edges toothed)

The Sycamore (Fig. 9) is one of the largest of the American trees, growing over 100 ft. in height and sometimes 10 ft. in diameter. The leaves are very large, some over a foot long. The fruit is a rough ball or button ball, about 1 in. in diameter, hanging on a stem 4 ins. long—these remain on the tree all winter.

The wood is cross grained, of a complicated structure, fibers interwoven, making it hard to smooth, but no wood is more beautiful, especially if quarter sawed.

The bark of the tree does not stretch as the tree grows, but falls off, exposing the inner bark in large, white patches, so that the tree appears to be shedding its bark as well as its leaves.

The Sycamore grows in the Mississippi Valley eastward to the Atlantic. The tree is from 90 to 120 ft. high, and from 5 to 10 ft. in diameter. It has large leaves, and rough balls or fruit, hanging on long stems.

The heart wood is a red-brown, the sap wood nearly white, close grained and cross grained; it will not split, is difficult to smooth, and medullary rays are conspicuous and beautiful when quarter sawed.

It is used for furniture, cabinet work, butcher blocks, tobacco boxes, and interior finishing.

First, clear, red sycamore, quarter sawed, costs $65 to $70 per M.

We use sycamore in the wood shop for cabinet making.

Maples

(Leaves opposite, edges toothed)

Maples grow in all the continents north of the Equator.

The Sugar Maple or hard maple is one of the principal trees of North America.

The wood has a fine, close texture, and is even used for type; it is so beautifully marked by bird's-eyes, blisters and curls that it is prized by the cabinet maker.

The wood is used for everything requiring wood of hard, close grain—flooring, furniture, shoe lasts and shoe pegs, car and ship making, and axles.

Sugar is found in the sap of the sugar maple; 25 gallons of sap may be taken from a tree in a season, yielding about 6 lbs. of sugar.

Maples may be told by their two-seeded fruit or keys, the two wings of which spread differently in the hard maple and soft maple.

The leaves turn from green to red, and other brilliant colors in some species, and from green to yellow with no red, in others.

Sugar Maple (Hard Maple)

The sugar maple (Fig. 10) grows in the United States east of the Mississippi.

The tree is 75 to 90 ft. high and from 1 to 3 ft. in diameter.

The wings of the keys are less than right angles, and ripen in the autumn; one seed cavity is usually empty. The leaves turn to a brilliant red and other colors.

The heart wood is white, much of it brown; the sap wood is whiter, very compact and close grained, with markings of curls, bird's-eyes or blisters; it is very hard, wearing evenly, tough and strong.

It is used for furniture, veneers, show-bill type, flooring, and lasts and pegs for shoes.

Fig. 10.—Sugar Maple Leaf and Keys

Fig. 11.—Silver Maple Leaf and Keys

Silver Maple (Soft Maple)

The Silver Maple (Fig. 11) grows from the Mississippi Valley east, and into Canada.

The tree is from 50 to 80 ft. high, and from 2 to 4

ft. in diameter. The maple key has long, stiff, more than right-angled wings; the leaves are white underneath, and turn yellow in autumn.

The heart wood is brown, and the sap wood white, compact, close grain, light in weight and more easily worked than hard maple.

It is used for wooden ware, interior finishing, and turned work.

There are only small quantities of sugar in the sap.

First, clear white maple costs from $60 to $65 per M.

We use maple in the shop for cabinet making.

Birches

(Leaves alternate, edges toothed)

Birches grow in Asia, Europe, and North America, forming large forests in Canada and the United States. The bark is water-tight and pliable, and contains resinous oils, making it durable, so that it is intact after the wood inside fallen trees has rotted away.

The bark can be separated into thin layers, and was used to write upon as early as 600 years before Christ.

Houses are covered with the bark, and utensils and ropes made of it. The American Indians made their canoes, tents, troughs and buckets of it.

The wood is fine grained, very stiff and strong. The leaves of the several different kinds of birches are similar, but the bark of each is different, and gives the trees the names: White Birch, Paper Birch, Red Birch, Yellow Birch, and Sweet or Cherry Birch, the leaves, bark and twigs of which are spicy and sweet.

The Paper or White birch grows farther north than any other American deciduous tree.

White Birch (Paper Birch, Canoe Birch)

White birch (Fig. 12) grows in northern United States, Canada and Alaska.

The trees are from 50 to 70 ft. high, and 1 to 2 ft. in diameter.

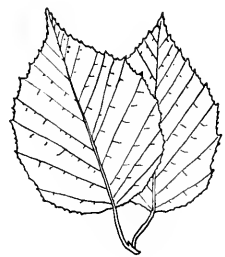


FIG. 12.—Paper Birch Leaves

It has smooth, white bark on trunk and limbs, which splits freely into paperlike layers.

The heart wood is reddish brown, the sap wood white, close grained, strong and tough.

It is used for paper pulp, and shoe lasts and pegs.

Red Birch (River Birch)

Red birch (Fig. 13) grows in Mississippi Valley, eastward.

The tree is 40 to 75 ft. high, and 1 to 3 ft. in diameter.

The bark is dark, red-brown, and scales off.

The heart wood is light brown, the sap wood white, close grained, hard and strong.

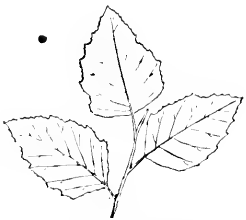


FIG. 13.—Red Birch Leaves

The wood stains easily and resembles mahogany when colored. Curly birch is most beautiful and is used to make the finest furniture.

It is used for furniture, interior finishing, and wooden ware.

Sweet Birch (Cherry Birch)

The Sweet birch (Fig. 14) grows east of the Mississippi, into Canada.

The tree is 50 to 75 ft. high, and 2 to 3 ft. in diameter.

It has dark, red-brown bark, which does not separate into layers. The leaves and bark are sweet and spicy.

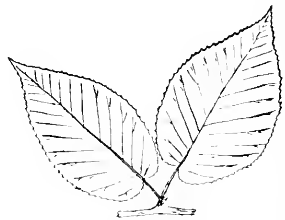


FIG. 14.—Cherry Birch Leaves

The heart wood is dark brown, red colored; the sap wood is light brown, close grained, stiff and strong.

It is used for furniture and wooden ware.

The wood is called Mountain Mahogany, Mahogany Birch, in the South.

First, clear red birch costs $40 per M.

We use birch for cabinet making in the wood shop.

WOOD

Wood has been and will be the most widely useful material for construction. There has been a lack of knowledge about wood, even if it is so common, and it has been much wasted. Iron and steel are better known, but wood is a complicated structure, and two pieces cut from the same tree may vary in strength, hardness and durability, and in keeping straight. Different kinds of trees yield different woods—the soft, straight grained white pine, the hard curly maple, the tough, elastic hickory. The way the log was cut, whether quarter sawed or otherwise, and the way the wood is piled and kept, influence its behavior and its quality.

Carpenters and builders use pine, because it is so plentiful, can be had in large, straight pieces, is light in weight so it can be shipped cheaply and handled easily; it is elastic, strong, works easily, nails easily; it is used in work that does not need to have a fine appearance.

The furniture maker uses woods that are hard and have a beautiful grain, that are strong and tough, and will keep a good joint and take a fine finish, since he puts the greatest amount of work on his wood, and does not care if it is costly. Such woods as mahogany, cherry, walnut, oak, maple, sycamore, and birch are cabinet woods.

The wagon maker wants hickory, which is hard, tough and elastic.

The carriage builder, cooper and shingle maker need straight grained, easy splitting woods, such as hickory, oak and selected pine.

Structure

The stems of plants consist of three different tissues.

1st—The Pith, or Medulla, consisting of soft and large thin-walled cells, full of sap or other nourishing material the first year, while growing, and becoming light, dry, and empty as the tree grows larger every year.

FIG. 15.—Section of Silver Maple (at the end of the first year)

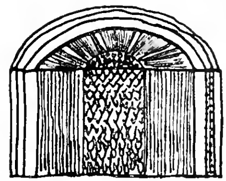


FIG. 16.—Section of Silver Maple (at the end of the first year, showing pith, wood, and bark, magnified)

2d—The Layer of Wood—traversed by the medullary rays—composed of woody tissue—many sided, thin-

walled cells—some large, open ducts—some spiral ducts. The outer part of this layer is the live part of the tree.

3d—The Bark or Rind—green in young plants, but soon covered with bast cells; they are like wood cells, but longer, larger, more elastic, and thicker walled. These long fibers make linen in flax and cordage from hemp.

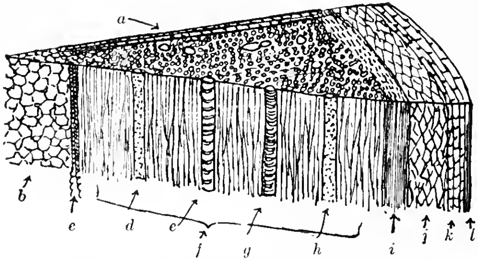


FIG. 17.—Section of Silver Maple at the end of the first year, highly magnified: *a*, medullary ray; *b*, pith; *c*, spiral vessels of medullary sheath; *d*, *h*, dotted ducts; *e*, counter duct; *f*, wood; *g*, annular duct; *i*, inner fibrous bark; *j*, green bark; *k*, corky envelope; *l*, outer bark, epidermis. (See Figs. 15, 16)

The cambium layer is the living and growing part of the tree; it is the layer between the woody tissue and the bark. The cells of this layer multiply by division, making new wood cells on the inside and new bast cells or bark on the outside.

Annual rings show the amount of growth each year. Each ring is caused by the darker, closer, slower growing summer wood on the outside, showing against the lighter, more open, softer, quicker growing spring wood.

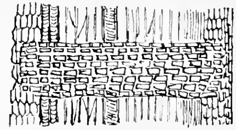


FIG. 18.—Vertical section of Maple Branch (at the end of the first year, showing medullary ray from pith to bark, magnified)

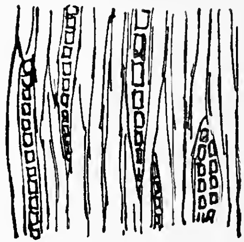


FIG. 19.—Cross section of medullary rays (magnified)

Sap wood consists of the last few rings still alive, whose cells are open to let the sap flow through to feed all parts of the tree, and also to store the food, worked over by the leaves, for winter's use.

Heart wood is the wood inside the sap wood, it is dead, so far as receiving nourishment goes; this wood is hard and firm, and supports and stiffens the tree.

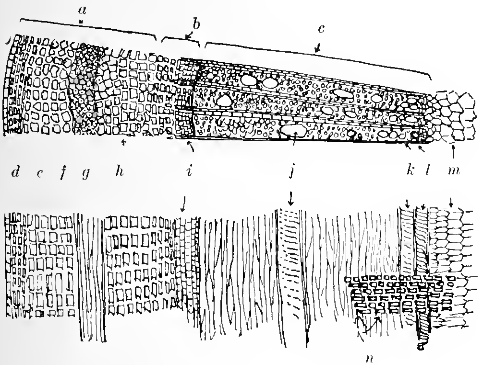


FIG. 20.—Cross and Vertical sections of stem at the end of the first year (magnified): *a*, bark; *b*, cambium layer; *c*, wood; *d*, epidermis; *e*, corky bark; *f*, green bark; *g*, fibrous bark; *h*, inner bark; *i*, cambium layer; *j*, *k*, dotted ducts; *l*, spiral duct; *m*, pith; *n*, medullary ray

Medullary or Pith Rays—Beside the vertical cells, there are horizontal cells, extending from the pith to the bark, radiating from the pith in all directions, binding the vertical cells or fibers together.

Food

The food of a tree is the mineral and chemical matter taken up from the ground by the sap or water, through the roots, the stem or trunk, the limbs, and finally the leaves, where it is exposed to the light and sun, and chemically changed, then carried down again to feed the tree.

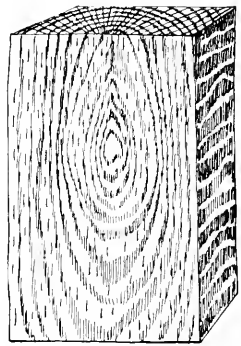


FIG. 21.—Board with edge quarter sawed. The annual rings shown on the top end of the board appear on the face of the board as grain; the medullary or pith rays appear on the edge as rays or lights

The water, or sap, is taken up by the little root hairs which grow on the rootlets, and carries various mineral

compounds, which it holds in solution. These compounds are the earthy parts of the tree, which reappear in the form of ashes, when the tree is burned. The water, which contains these compounds, goes straight to the leaves, in which the most important part of the feeding of the tree takes place—the taking up and breaking up of carbonic acid gas, which with the water forms starch, and which, combined with the mineral in the water, forms the more complex food of the tree.

This change to starch can go on only in the presence of sunlight and heat, and also through the action of chlorophyll, a substance that absorbs and decomposes carbon dioxide, resulting in the throwing off of oxygen and the formation of new organic substances. It is this substance, chlorophyll, that is the chief means by which mineral materials are changed into food, so nearly all plant and animal life depends on them for existence. The little plant cells containing chlorophyll, under the influence of the sunlight, combine this carbon with the oxygen and hydrogen in the water into new compounds, in which nitrogen and the earthy parts—magnesium, calcium, iron, sulphur, phosphorus, potassium and chlorine are present—these being called essential elements, because trees and other plants must have them in order to be thrifty.

Other elements are also absorbed, if in the soil, in soluble form, but none of them are used separately and alone, as they rarely exist as separate elements, but are blended together.

The plant obtains both hydrogen and oxygen in water—potassium, nitrogen and oxygen are often united in the form of potassium nitrate, a very valuable food for plants.

Trees can absorb these mineral foods only when they are in solution in the water taken up by the root hairs. Many compounds of soil, which contain good food elements, are insoluble in soil water, and therefore cannot be used. Potassium, one of the essential elements, is often in combination with aluminum and silicon, and other elements, so as to be insoluble and useless. But chemical changes are slowly going on in the soil, by which insoluble compounds are made into soluble compounds. Cultivation and fertilization hasten such changes, and that is why fields should be plowed and harrowed and worked over.

These foods are first digested in the leaves, just as food is digested in the body, and are then sent to all living parts of the roots, stem and crown, where they pass through another process of digestion, and are then used at once, or stored away until needed.

Density

Wood is dense when the woody fibers are multiplied and packed close together, without fissures between. Such compactness gives to the wood a hard, smooth appearance, as seen in box-wood, apple-tree, maple.

The density of wood may be found by making prisms of the wood, which can be easily measured—then taking the weight of the prisms. The ratio of the weight to that of the same volume of water will be the density. This density varies in different blocks of wood from the

same tree, depending on the form and position of the fibers, and the part of the tree from which the samples were taken. Heart wood is much more dense than sap wood, and the lower part of the trunk of the tree is more dense than the upper part or branches.

Density also depends upon the difference in structure of the cells—upon the amount of solid matter in them, or the water and air which they contain. The substance forming the outside of each cell is cellulose, and in this is incrusted harder matter, which is found more in hard wood than soft—is abundant in fruit stones and in certain pears; it is more abundant in heart wood than in sap wood—heavy and hard woods contain it in greater quantities than light or white wood; it contains more hydrogen than cellulose, and having more carbon and also more hydrogen, its combustion produces more heat than cellulose, and this is the reason why hard, dense wood gives more heat when burned than soft wood; the density of wood seems to measure the degree of combustibility.

To find the density of wood fibers, the wood is reduced to a fine powder by filing with a file or rasp, dried at 100° F., then placed in a small bottle full of water from which air is exhausted, and left for some time. All wood fiber has the same specific gravity, equal to 1.5—iron wood, oak, poplar—the extreme variations all included between 1.51 and 1.52.

The comparative weight of some woods and an equal volume of water is as follows:

Pomegranate, 1.35; ebony, 1.33; box tree of Holland, 1.32; green and black ebony, 1.20; core of oak, 60 yrs. old, 1.17; English oak, .93; beech, .85; apple-tree, .79; maple, .75; cherry, .75; mahogany of St. Domingo, .75; northern pine, .73; birch, .72; sycamore, .59; Honduras mahogany, .56; white pine, .56; poplar, .38; cork tree, .38; elder tree pith, .07.

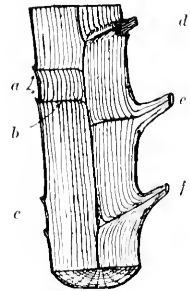


FIG. 22.—Section of tree: *a*, dormant buds; *b*, trace to pith; *c*, undeveloped buds; *d*, limb dead for four years; *e*, limb which started two years ago from dormant bud; *f*, normal limb

Growth

Since the food is digested or changed in the leaves, trees should have a large crown, or top, to grow well.

But a large top means large branches, which spoil the trunk of a tree for lumber.

The branches form knots, by growing out from the inside of the trunk or stem, when the tree is young, and being surrounded each year by a layer of new wood.

So trees are allowed to grow close together. Small branches grow out as usual, but being shaded by the other trees, getting no sunlight, the leaves send no nourishment to the branches, which soon die and fall off, leaving the trunk round and straight—making clear lumber, free from knots.

Growth of trees depends on kind of soil, which contains its food supply or the proper amount of water to make it soluble, that the roots may take it up.

Trees can be cut for fence posts in 12 or 15 years. The hardy catalpa grows large enough for railroad ties in 15 years, while it takes oak 30 years; trees for fine, wide lumber take from 60 to 100 or 200 years.

Cutting

Trees should be cut in the fall and winter, because then there is very little movement of sap.

Moisture in Wood

100 lbs. of green wood contain about 25 lbs. of water, 74 lbs. of wood and 1 lb. of ashes.

Wood must be seasoned or dried before using, by piling it under shelter, in such a way that air may get to all sides of the boards, or by drying it in a kiln—a hot room.

Shrinkage in Wood

Since the wood cells have thick walls and thin walls, and these are intermixed, and since spring wood shrinks more than summer wood in the same year's growth, wood strains and warps as it dries out.

Since the summer wood is the newer wood, and also the larger part of each year's growth, the wood shrinks as shown in Figures 23-26.

Then since the fibers in the medullary rays shrink vertically, and the fibers in the annual rings horizontally, strains take place at right angles to each other, that cause the pith or medullary rays to separate from the

Fig. 23

Fig. 24

Fig. 25

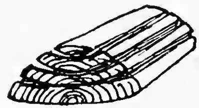


Fig. 26

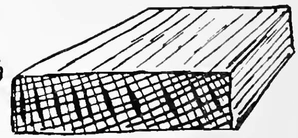


Fig. 27

fibers and thus make checks or shakes in the wood, especially if it is made to dry too rapidly (Fig. 27).

Grain of Wood

The small fibers, generally parallel to each other, give us the grain of the wood. Separating these fibers, or splitting the wood, is easier than breaking the fibers across.

Coarse grained wood has open, thick fibers; fine grained wood has close, small fibers.

If fibers lie parallel to the axis of the trunk the wood is straight grained, but often the direction is spiral or twisted around the tree (look at telephone and telegraph poles), making the board plane smoothly, with the grain on the front edge, and directly against the grain on back edge of the same face.

Then the fibers are oblique in one direction, and the next few layers oblique in the opposite direction, as in sycamore and gum, making cross or twisted grain.

The layer of wood under the bark is not always smooth; the new layer fills the depressions, and also adds to the high places, growing on in waves, making the wavy or curly grain.

When these elevations and depressions are very small, a board cut from such growth shows little rings or "bird's-eyes," seen in maple. Dormant buds also make small elevations, which, covered year after year by new wood, appear as little rings, each with a center, when the board is cut.

Drying

Many logs, as soon as cut, are rolled to some stream and tied together in rafts, or thrown into water near the saw mill. This soaking helps clean the wood by washing out the mineral matter, which is soluble. Many logs are sawed immediately after being felled. Before using, the boards and planks must be dried and seasoned, to remove the moisture.

Pine, spruce, cypress, cedar are dried fresh from the saw by artificial drying in a steam heated room or kiln, allowing four days for boards one inch thick.

Hard woods—oak, ash, maple, birch, cherry, sycamore, are "air-seasoned," piled in great piles with cross-pieces between each layer, for 3 to 6 months, and even 2 or 3 years to allow the wood to dry more gradually; then it is carefully piled in the kiln, heated to 160° or 180° F., and dried for 6 to 12 days, and sometimes much longer, for one inch boards; thicker lumber requires a much longer time. The dry wood, when exposed to the outside air, immediately takes up moisture again.

100 lbs. of pine wood, from the heart of the tree, will lose from 15 to 25 lbs. of water in drying; and in 100 lbs. of hardwood—oak, maple, sycamore—the heart wood will lose from 30 to 40 lbs. of water.

Hard and Soft Wood

Wood of the broad leaved trees, like oak and sycamore, is called hard wood, while wood of needle leaved trees or conifers, like pine or spruce, is called soft wood, though the division is misleading, as poplar, the wood of a broad leaved tree, is much softer than Georgia pine, a conifer.

Stiffness

Heavy wood is stiffer than light wood, because of the closer, finer, more compact fibers. Dry wood is also one third more stiff than wet wood. A joist or heavy timber laid with its yearly rings vertical, is stiffer than if the yearly rings are horizontal.

Products

Pines and fir trees contain resin in spaces between the annual rings. This resin or pitch is obtained by cutting or bleeding the tree, the resin flowing into a little box or pocket cut in the tree. This is dipped up and put into a still and heated, the hot vapor condensing into turpentine, and the thicker portion forming resin.

The wood and bark of most trees contain tannin, used to tan leather.

Wood fiber is manufactured into pulp, with the help of chemicals, from which paper is made.

Milling

"Timber" includes large sizes—joists and beams.

"Planks" are over one inch thick.

"Boards" are one inch thick, or less.

"Clear" lumber is free from knots or sap wood.

"Dressed" or "surfaced" or "sized" lumber is planed smooth, and is ordered—"100 ft. 1st clear, s2s" (size two sides).

Measurement

Lumber is measured by the "board foot," which means a piece 12 in. square and 1 in. thick. It is sold by the 1,000 ft., M., board measure (B. M.), at so much per thousand.

500 ft. board measure, costing $45 per thousand, would be ordered "500 ft. B. M. at $45 per M."

Boards less than 1 in., and veneers, are sold by square foot, face measure.

Piles are sold by running feet—40 ft. or 50 ft. piles.

Fence boards and studs are sold by the piece.

Lath and pickets and shingles are sold by the bundle.

Values

Some very valuable wood is sold by the pound.

Mahogany is from $400 to $500 to $1,000 per M.—kiln dried.

Cherry is $180 to $200 per M.

Oak—Q. S. (quarter sawed), $80 to $90 per M.

Sycamore, Q. S., $60 to $80 per M.

Gum, $35 per M.

White pine, 1st clear, $70 to $80 to $100 per M.

"Quarter sawed" or "rift sawed" lumber is lumber sawed so that the face of the boards is parallel to the medullary rays, or nearly so (Fig. 28).

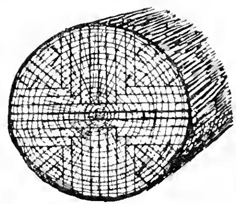


Fig. 28

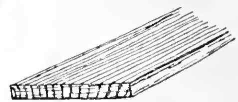


Fig. 29

Boards sawed in this way do not warp or twist much, as the yearly rings are on edge, through the board (Fig. 29).

Bastard lumber is lumber sawed so that the yearly rings are somewhat parallel to the face of the boards, and as the spring wood and summer wood in each yearly ring are different in structure (the summer wood is firmer and darker in color), markings are made on the face of the boards (Fig. 30).

Boards sawed in this way warp badly, as the outer layers of wood are younger and newer wood, and shrink

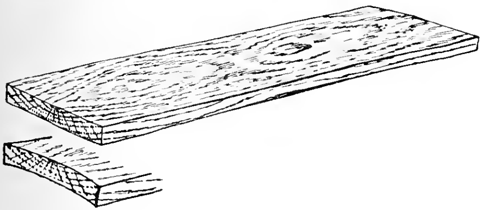


Fig. 30

much more than the older layers, causing the board to be pulled back, or "warp" toward the outside of the tree (see Fig. 30).

SUGGESTIVE QUESTIONS

Wood

1. What can you say of the usefulness of wood?
2. What kind of wood does a carpenter and builder desire?
3. What special qualities should the wood used by a furniture maker possess?
4. What hard, elastic wood is used by the wagon maker?
5. Is the wood sawed or split for wagon wheel spokes?
6. What beautiful wood is used for heavy casks and barrels? Why?

Structure

7. Name and describe the three tissues or parts of the stems of plants.
8. Is the heart of a tree dead?
9. What are medullary rays?
10. What is the live part of a tree?
11. Describe the bark.
12. Of what is hemp rope made? Linen? From what part of the tree does this substance come?
13. Make a sketch showing a stem one year old, magnified sufficiently to show the different tissues, the cambium layer, and the medullary rays.
14. Describe the cambium layer.
15. What are annual rings? How are they caused? How may we tell the age of a tree?
16. What is sap wood? Does it show on a board?
17. What part of a tree makes the good lumber?

Food

18. What is the food of a tree? Tell how the tree digests its food.
19. How does water or sap enter the tree?
20. What does the water take with it?
21. What are wood ashes?

22. What important digestive action takes place in the leaves?
23. Does this action take place at night?
24. What is chlorophyll?
25. Explain carefully why nearly all animal, as well as plant life, depends on chlorophyll.
26. Name some of the essential mineral elements.
27. Name a compound which is a valuable food for plants.
28. What is aluminum?
29. What necessary sharpening apparatus is almost pure silicon?
30. Why do farmers cultivate the ground?

Growth

31. Do wide-spreading shade trees make good lumber? Why?
32. What are knots? Loose knots and tight knots?
33. Make a sketch of a section of a trunk, showing the cause of a loose knot—of a tight knot.
34. Why should a tree have plenty of water? Would a good soil and very little water suffice?
35. How long will it take for trees to grow large enough for fence posts?

    Does oak grow as fast as catalpa? How soon may a catalpa be cut for railroad ties?

    How long will a tree have to grow to produce a fine, wide board?

Cutting

36. When should trees be cut? Why?

Moisture

37. In green wood, what is the proportion of moisture?
38. What is meant by seasoning wood?

Shrinkage

39. What causes shrinkage and working in wood?
40. What causes checks and shakes in wood? Illustrate by sketch.

Grain

41. What is meant by the grain of wood?
42. Name a coarse grained wood. A fine grained wood.
43. Explain how cross or twisted grained sycamore or gum grows.
44. What forms the beautiful, curly grain in some woods?
45. Tell how bird's-eye maple grows.

Drying

46. Name a very general method of cleaning logs before sawing.
47. Can boards, or any other wood, be used to advantage immediately after sawing?
48. What woods may be dried in a heated room or kiln fresh from the saw?
49. How long does it take to kiln-dry 1 inch boards of this kind?
50. What is air drying? How long does it take?
51. Why should hard woods be air seasoned first?

52. Name the woods with which you are familiar, that require air drying, then kiln drying.
53. How long does kiln drying take for 1 inch thick hard wood?
54. How much weight in moisture is lost by thoroughly seasoning 100 lbs. of pine? How much in 100 lbs. hard wood?

Stiffness

55. Is heavy or light wood best for stiffness? Why? Which is stiffer—dry or wet wood?
56. How may the annual rings be laid in heavy timbers so as to add to the stiffness?

Products

57. What is resin? Explain carefully how it is gathered, and how two very common products are made from it.
58. What is tan bark, and for what is it used?
59. Of what is some paper made?

Milling

60. Give the sizes of the following: timber, planks, boards.
61. What is meant by clear lumber?
62. What name is given lumber that is planed smooth, and how is such lumber ordered?

Measurement

63. How is lumber measured? What dimension is a board foot?
64. How is lumber generally sold in quantities?
65. What sizes are sold by face measure?
66. How are piles sold?
67. What lumber is sold by the piece?
68. What lumber is sold by the bundle?

Value

69. Can you name a wood sold by the pound?
70. Give, approximately, the value of a thousand feet of mahogany—cherry—oak—sycamore—gum—white pine.

Quarter Sawed Lumber

71. What is quarter sawed lumber? Explain by sketch.
72. Why is lumber sawed in this way more valuable?
73. What is bastard lumber? Explain carefully why lumber sawed in this way does not keep true. Is such lumber good for flooring?
74. Show in a sketch just how, and in what direction, this bastard board will warp.

CARPENTRY

SAWING

Get from the lumber pile a board, or part of a board, of white wood, that is at least 8 ins. or 9 ins. wide, and 1 in. or $\frac{7}{8}$ in. thick.

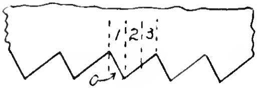


Fig. 31

Select your cross-cut saw.

Notice that the teeth of this saw are cut in the blade as in Fig. 31, having the front of the tooth, O, one third

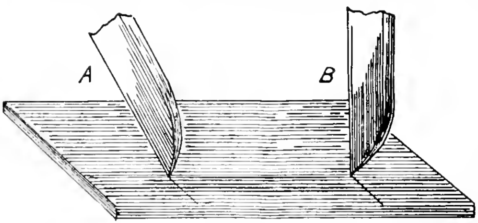


Fig. 32

of the length of the whole tooth. This one third shows the amount of pitch of the tooth. Saws for general use, to cut hard wood—cherry, oak, maple, as well as pine —have teeth cut in this shape, with one third of the tooth slanting forward.

To show why this slant or pitch is necessary, a board is shown (Fig. 32), across which we wish to make a deep mark with a knife. Holding the knife nearly perpendicular as at B, it will push harder and will not cut so smoothly as if it was inclined forward, as at A. It follows that the cutting edge of a cross-cut saw should incline forward as at C, rather than stand perpendicular as at D.

Fig. 33

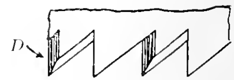


Fig 34

Setting Saws

All saws are set—that is, the extreme points of the teeth are hammered over, one tooth to the right, the next to the left—to make a wide enough path, or kerf, for the blade of the saw. Always joint your saw before setting, by making it perfectly straight along the points of the teeth, by filing gently with a long, straight file, held lengthwise with the saw.

The kerf, or path of the saw, must be considered and

measured when cutting several pieces of a certain length from a board. For example, can you saw from a board that is 4 ft.–0 ins. long, four (4) pieces 12 ins. long?

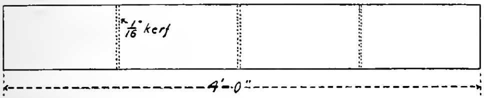


Fig. 35

Cross-cut Saw Filing

To file your cross-cut saw, file from the heel (handle) to the point, holding your file horizontally, and at about 45° with the length of the saw (Fig. 36), filing only every second tooth, from one side, reversing the saw to file the intervening teeth. A sharp knife edge is thus filed on the front of each tooth, the fiber of the wood being cut twice, by a knife tooth, on each side of the saw. Also a fine wire edge is made by the file on each side of the saw, if alternate teeth are filed from both sides. This wire edge, if wholly on one side, would make the saw run off your line, as the wire-edge side would cut faster. A saw which has been run against a nail on one side, will also run off the line, as the sharp side cuts faster.

If the saw runs off the line after careful filing, it may be made to saw straight by laying it on the flat bench top and gently rubbing the sharper side with the oil-stone or a fine file.

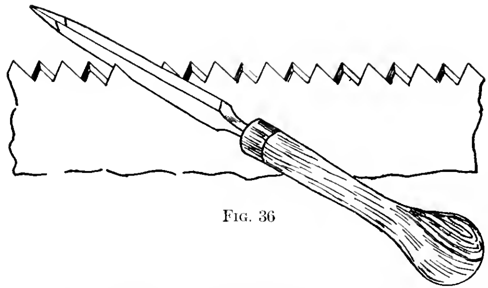


Fig. 36

To saw smoothly in hard wood, a fine-toothed cross-cut saw is necessary, with about 10 points or teeth to the inch.

Select your rip saw.

Fig. 37

The teeth are cut in the rip saw as in Fig. 37, with the front of the teeth square or at right angles with the edge of the saw, having no slant or pitch. The rip saw having only to separate the fibers, generally has larger teeth than the cross-cut, thereby cutting faster with the same amount of power or muscle.

Set the rip saw by hammering every alternate tooth to the right or left.

Having no fibers to cut across, the rip saw is filed square across, filing one half the teeth from each side, making of each tooth a small, sharp chisel, each chisel taking off its thin shaving.

The rip saw should be held at an angle of about 45° with the board being cut, as shown in Fig. 38. This makes a shearing cut.

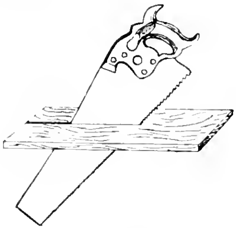


Fig. 38

To rip smoothly in hard wood, a fine toothed rip saw is necessary with 8 teeth or points to the inch.

The Back Saw

The back saw is a cross-cut saw, with much finer teeth, and is filed like a cross-cut, to give a cutting edge to the front of the tooth. The blade is made very thin to cut a narrow kerf, and is strengthened by a stiff back. The back saw is used for much finer work than either the cross-cut or rip saw, and should have 12 teeth or points to the inch.

Examine the end of your board to see that there are no shakes or cracks. Measure off from a good end 8 ins. With a large steel square and a sharp knife (no lead pencil) make a clear, sharp line across the board. Saw to the line, and just outside, that your instructor may see a $\frac{1}{32}$ in. deep knife cut on the top edge of the end and the rough saw cuts below, as shown in Fig. 39.

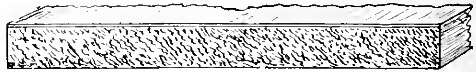


Fig. 39

Mark off with knife and large square $\frac{3}{4}$ in. from each end of your 8-in. board, knifing across the face, and down both edges, leaving space between knife marks $6\frac{1}{2}$ ins. long (hold this short board in vise while sawing).

Saw off both ends to knife lines, and show your instructor a board exactly $6\frac{1}{2}$ ins. long, with a clean knife cut on face and edges of both ends (Fig. 40).

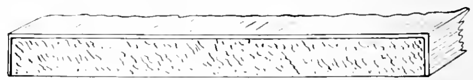


Fig. 40

Measure off the center of your board lengthwise. See that your gauge is sharp, then gauge a light center line. Rip to one side, but against this gauge line. Set your gauge so that it measures with your rule exactly $\frac{1}{2}$ in. Gauge on one edge of each piece a light, sharp line. Rip

Note.—The drawings on saws are taken from Disston's "Hand-Book for Lumbermen."

a $\frac{1}{2}$-in. strip from each piece, and show your instructor two pieces each $\frac{1}{2}$ in. wide—one piece showing two gauge lines, and the other one gauge line along edge.

Mark off with knife and try-square four (4) $\frac{1}{2}$ in. long blocks on one of these strips, knifing all around the strip. Saw with back saw, holding strip in vise or bench hook, and show your instructor four blocks, with a clean knife-line all around one end.

Grinding

The grindstone does not sharpen your plane-bit or chisel. The oil-stone sharpens. The bevel or grind on your plane-bit (Fig. 41) should be $\frac{3}{16}$ in. or $\frac{1}{4}$ in. long; on

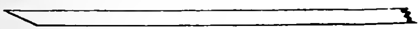


Fig. 41

your chisel (Fig. 42) $\frac{3}{8}$ in. or $\frac{1}{2}$ in. long, the length of bevel depending on the temper of the bit or chisel, and

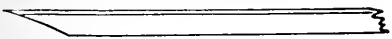


Fig. 42

the hardness of the material to be cut. If the bevel or grind has been shortened and rounded over as at O (Fig.

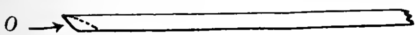


Fig. 43

43), by wearing away the end of your tool in sharpening on the oil-stone, then grind away the steel at O until the right bevel is restored.

The side of the grindstone running away from you is the safe side at which to grind (Fig. 44), though the stone grinds tools more quickly on the other side.

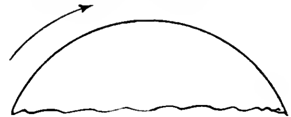


Fig. 44

Grind your tool perfectly square and straight across, and a tool well ground should last one month before the bevel again gets so short as to make the chisel or plane-bit cut hard. The tool must be shown to your instructor and his permission secured before grinding.

Sharpening

Hold the plane-bit or chisel on the oil-stone with both hands, at such an angle as to feel the grind or bevel

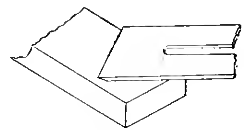


Fig. 45

lying on the stone (Fig. 45). Use the whole stone from one end to the other.

Sharpen only long enough to turn up a feather edge

on the flat side of your bit. Feel for it. Press a little harder on each edge of the bit, to make a heavier feather toward the edges, which will round your bit slightly across the whole end. Then turn the bit over, holding it perfectly flat on stone (Fig. 46), and rub gently.

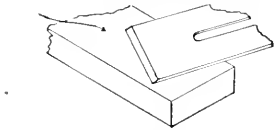


Fig. 46

Continue to turn it over and back, rubbing gently to bend feather off. Whet the bit on your hand. Examine it closely for any feather. See that it is not too rounding across the whole end. The width of a single hair, higher in the center of the bit, enables you to plane off a shaving without the edges digging.

Cover or Breaker

Screw on your cover $\frac{1}{32}$ in. back from the sharpened end, or even a scant $\frac{1}{16}$ in. back, for very straight grained soft wood. For curly or cross-grained wood the thickness of a hair is the proper distance back. The cover acts as a breaker or bender of the shaving, giving the bit a new start, instead of allowing it to follow the downward direction of the grain.

In whittling the wood with a knife, the blade will follow the grain. If we could fasten on the knife blade a strip of steel, $\frac{1}{16}$ in. back from the cutting edge (Fig. 47), then push as before, the blade would sink into the wood only so far as the steel is back, the shaving hitting the steel, bending or breaking over, and giving

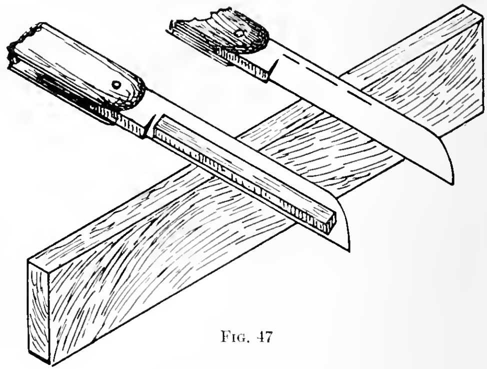


Fig. 47

the knife another start near the surface, instead of following the grain under the surface. The surface of the cross-grained and curly board is roughened and dug into the exact distance your cover is back from the end of the bit; push your cover closer, the rough places partly disappear; push cover down within a hair line of the end, and the rough holes entirely disappear.

Setting Your Plane

Hold the toe (the front) of your plane close to your eyes with the face up. Sight along the face to see that

the bit just shows through the throat, and that one edge of the bit is not higher than the other.

To Plane a True Surface

Experience has taught that the short, smooth plane can be used to better advantage on short work—the longer jack plane, by hanging over the ends of the wood, requires just so much more pressure to hold down. Plane with the grain and on top of it, not against it, or across it, taking a shaving the whole length of the board. Care must be taken not to plane more shavings off of one corner or edge, making that place low, as the board will then rock or wabble on its higher corners, making it in wind (*i* as in *find*). Plane as if you were attempting to make the board concave or hollow from end to end, which is done by pressing heavily on the toe or front of the plane as you start your shaving, and on the heel or back end as you near the forward end of your board, the front of the plane being raised in the air.

Fig. 48 shows the planes in an exaggerated position,

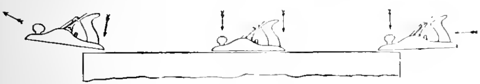


Fig. 48

the arrows pointing in the direction of the pressure as applied by both hands, demonstrating a good method.

Press hard on the front of the plane, while pushing forward, and not down, with right hand.

Equalize the pressure in the center.

Press hard on back end to complete a full length shaving, while throwing up the front of the plane.

To Prove a True Surface

Try the face of the board lengthwise and across with the edge of your plane, to see that it is straight either way. The edge of your plane makes a good straight-edge.

Then try the face of the board on the true bench top, or other true surface, to see that it lies perfectly flat. If it rocks or wabbles it is in wind—two opposite corners are higher than the others. Two or three silky shavings off each high corner will generally true the surface.

To prove the surface true, lay two sticks, called sight sticks, across either end of the board, and sight along their top edges. Two opposite edges of these sight sticks must be planed perfectly straight, and parallel to each other (Fig. 49).

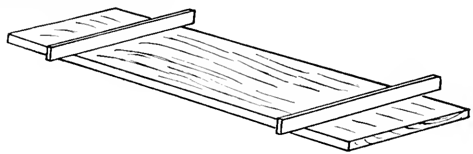


Fig. 49

If sight sticks are not available, two large carpenter's squares may be laid across the board (Fig. 50).

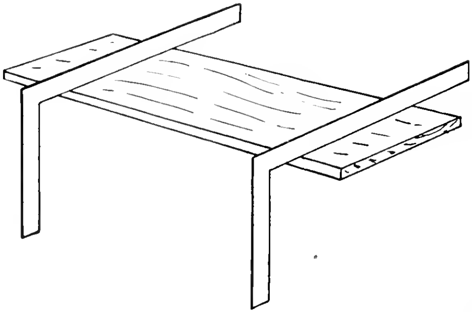


FIG. 50

To Plane Edges Square with Marked Face

Examine your plane to see that the bit is set perfectly true with the face—that neither edge is high. With your try-square try the edge of your wood, from the marked face, noting which side of the edge is high. Move the whole plane over toward the high side, until the rounded center of the plane-bit is over the high edge. Notice that the plane, instead of being tipped toward the high edge to plane it off, as beginners usually proceed, is leaning with the slanting edge toward the low side. The plane-bit, being slightly rounded across the whole end, will cut at its center, while the edge, being up in the plane, cuts off nothing. A shaving is thus made, thick on one edge and of no thickness on the other. Three or four such shavings will bring down the high edge.

Under no circumstances is the plane-bit ever to be thrown over to one side by the lever, to take down high edges. A plane, set out of true, is worthless, and its use may cause hours of extra labor.

To Plane Ends from Marked Face and Edge

With your try-square try the end to find the high places. See that your plane is set perfectly true, and

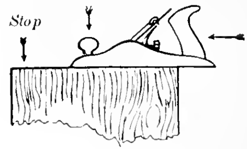


FIG. 51

is very sharp. Pressing hard on the front of your plane, plane only part way across the end, stopping a half inch or more from the back edge (Fig. 51). Reverse your

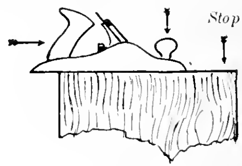


FIG. 52

plane and plane back again, stopping a half inch or more from first edge (Fig. 52).

Never, under any circumstances, chamfer or bevel off the back corner, to enable you to plane clear across the end.

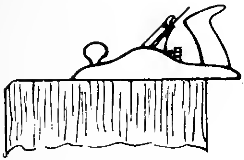


FIG. 53. A poor method

NOTE.—This method is sometimes used for rough work.

Learn to plane rightly for right's sake, and for future accurate fitting, and not for the convenience of the moment. Do not suppose that the cabinet woods, cherry, oak and sycamore, will be given you in pieces large enough to enable you to chamfer off a corner, thereby wasting a long strip on edge or end.

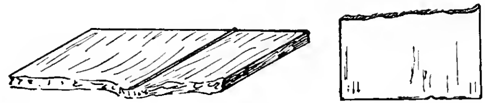
Marks and Chatters

An experienced worker can tell the condition of your plane, and know how much skill you possess, by merely looking at your planed board.

Small hollows, or cuts, across the grain, at the back end of your board, show a lack of pressure on the front end of your plane as you start—the back end having been pushed down slightly, the bit makes a short dig and then jumps out.

The same marks at the front end show pressure at the toe or front of your plane, instead of a lifting in the air. These marks are called chatters.

A small bead on the surface of your wood (Fig. 54, *a*) is caused by a nick in your plane-bit (Fig. 54, *b*). Sharpen on your oil-stone until a good, heavy feather is formed, when the nick will disappear.



a *b*

FIG. 54

A small groove or scratch in your wood may be caused by the soft iron of the face of your plane being raised by hitting your iron bench stop or a chisel. Feel for it, and having found the raised plane, oil-stone it off by gently rubbing with the oil-stone held in your hand.

Remarks

Thin, silky shavings, and very few of them, show the careful, thoughtful, and good workman.

The man who examines and tries his work, with his try-square and rule, continually, knows what he is doing.

A great pile of short, thick shavings; a board in wind and full of chatters; a perspiring boy—all point to the careless, thoughtless worker.

Listen to your instructor; follow his directions, and use your good, common sense.

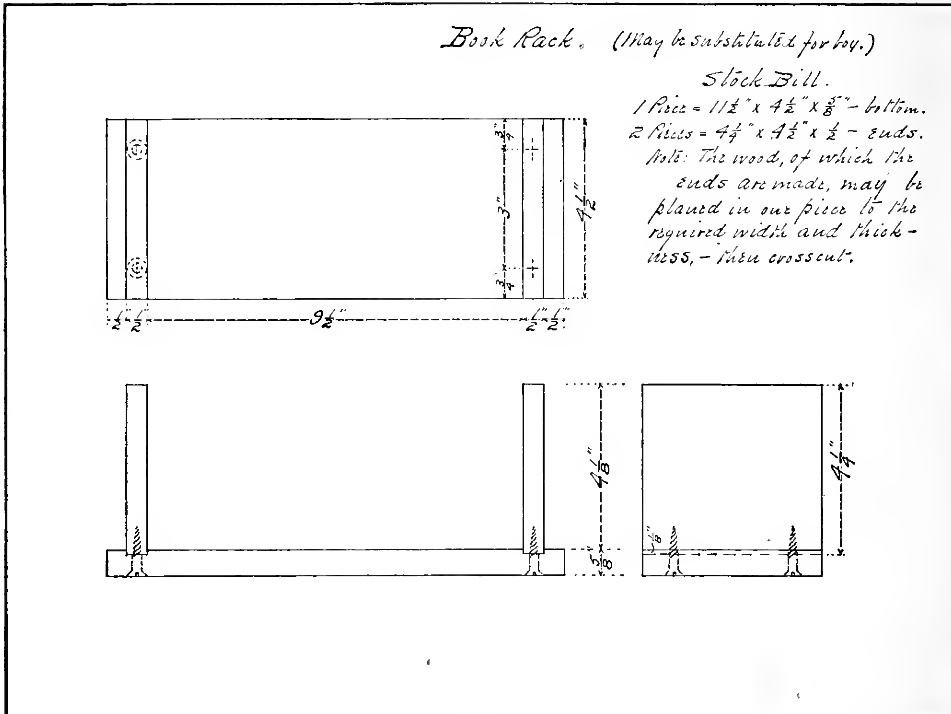

Book Rack. (May be substituted for box.)
Stock Bill.
1 Piece = 11½" x 4½" x ⅝" – bottom.
2 Pieces = 4¼" x 4½" x ½ – ends.
Note: The wood, of which the ends are made, may be planed in one piece to the required width and thickness, – then crosscut.
¾"
3"
¾"
4½"
½" ½"
9½"
½" ½"
4⅛"
⅝"
4¼"
⅛"

FIG. 55

Exercise. Book Rack (Fig. 55)

Plane pieces to exact dimensions.

Lay out base of rack with knife and try-square, knifing down both edges $\frac{1}{8}$ in.

Gauge lightly the depth of groove on edge of base with sharp gauge, and knife the gauge line.

Clamp the base board in vise, holding the thumb just to the knife-line to steady the saw (Fig. 56), and saw, with the back saw, a light kerf just inside both knife-lines.

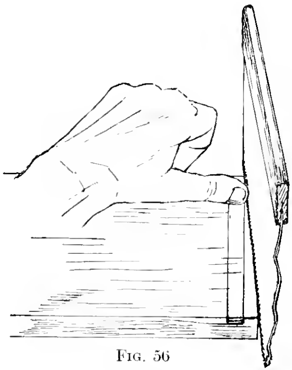


FIG. 56

Chisel out groove smooth and true to the saw kerfs. With the inch chisel held perpendicularly exactly in knife-line, pound gently with mallet, to complete the full width of groove (Fig. 57).

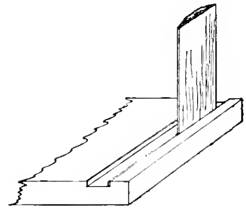


FIG. 57

Carefully smooth the bottom of groove, and try with try-square to prove the surface.

Lay out centers for screw holes on bottom face of base board.

Insert end of rack in groove, clamp in vise with one screw hole center showing above vise (Fig. 58). Prove

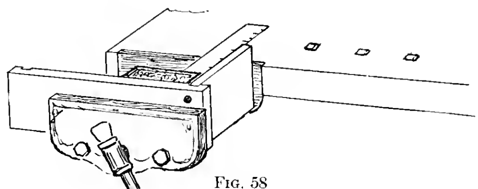


FIG. 58

that the end of the rack is square with base with try-square, pounding the end over gently with mallet or hammer, if out of square.

Bore a hole with $\frac{7}{32}$-in. bit (Fig. 59; the shank of the bit is marked with figure "7") through and through base board, and up into end $\frac{1}{4}$ in. or less, only.

FIG. 59

Bore with $\frac{4}{32}$-in. gimlet bit on up into end, making full depth of hole about $1\frac{1}{4}$ in.

To screw one piece of wood against another, so as to make a perfect joint, the first piece must be bored through and through, with a bit slightly larger than the diameter of the shank of the screw, that the piece may be drawn up close by the flat head of the screw, as it is screwed in.

The hole in the second piece should be slightly smaller than that part of the screw around which the thread circles.

With rose countersink (Fig. 60), countersink to re-

FIG. 60

ceive screw head, and screw in $1\frac{1}{4}$ in. No. 11 flat head wood screw. Reverse rack in vise, and screw in other screws. Clamp rack in vise and plane edges true. This can be done only by having the plane rest on the end piece while planing the base, and on the base while planing the ends (Fig. 61).

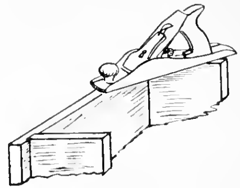


FIG. 61

Practice in Gauging

First, sharpen the gauge point with a fine file to a knife point; not a needle point (Fig. 62).

Second, set the gauge with your rule—never trust the scale on the bar of the gauge, but measure with your rule the distance from the scratch point to the head or shoulder piece.

Gauge from you (Fig. 63) always, allowing the point to drag, pressing the head of the gauge hand against the marked edge or face of your board, but bearing lightly with the scratch point on the board, to make the lightest line possible—the light line is the accurate line; the heavy gauge line has a dimension of its own, and planing the heavy line away will cause the wood to measure nearly $\frac{1}{64}$ in. under dimensions.

In gauging wide boards, 5 ins. or 6 ins. wide, hold the

gauge with the thumb behind the bar of the gauge, instead of behind the head, so as to steady the moving point (Fig. 64).

Never gauge across the grain of the wood. A scratch point does not make a smooth line across the grain, but merely tears the fibers.

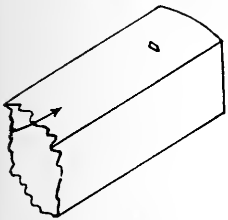


Fig. 62

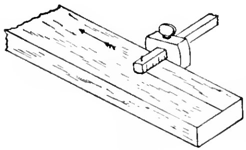


Fig. 63

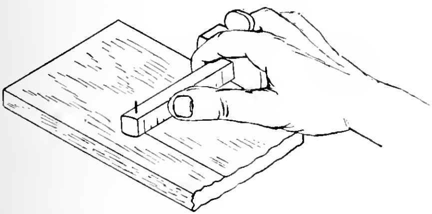


Fig. 64

Use a sharp knife and your try-square to mark across the grain.

Rules for Planing to Dimensions

True and smooth one side—and mark.

Joint (straighten and square) one edge from marked side—and mark.

Square one end—from marked side and edge—and mark.

Gauge to required thickness from marked side, plane to gauged line and smooth.

Gauge to required width from marked edge, and joint to gauged line.

Lay off with knife and square the required length from marked end, saw to knife-line, and square with marked side and edge.

Box Made of White Wood (Fig. 65)

Your instructor is to examine each end, each side, the top, the bottom, and try each with the try-square, measure each dimension on every piece, and sign his name to every one of the eight pieces; that he may detect and show you how to correct any dimension or any surface out of true, or edge out of square, and direct you to make over such pieces, and make them over again and again, until they are perfect—*because one bad piece spoils the whole box.*

Before nailing together, would it not be a good plan to take a thin, silky shaving off all the surfaces that are to be inside your box, making them clean and white?

Should nails be driven straight into the wood? Why?

The ends of the box are first nailed to the ends of the bottom; then the sides are nailed to both the bottom

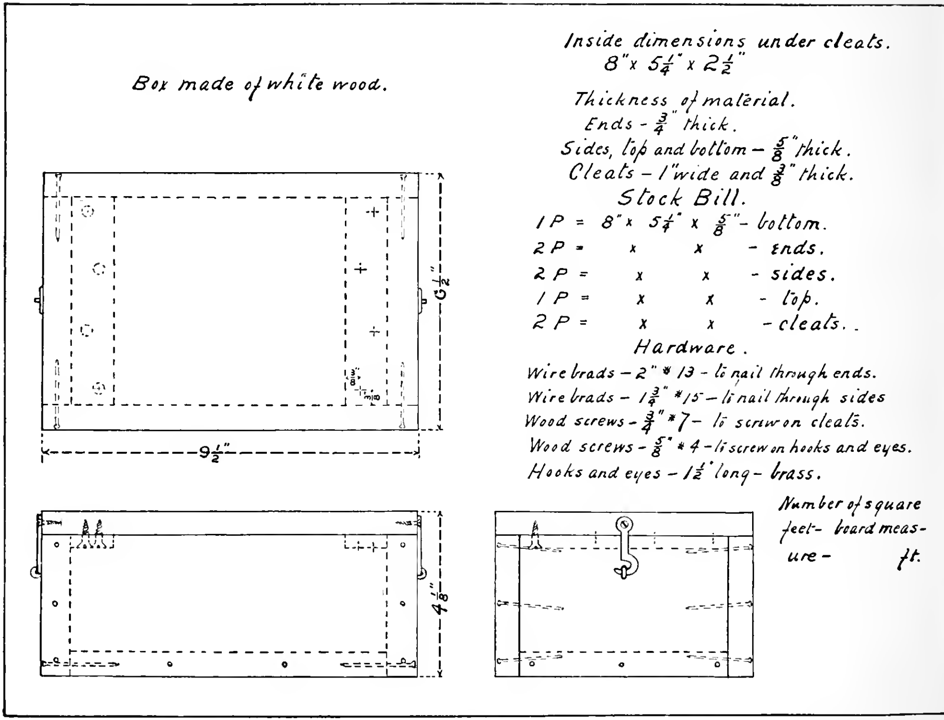

Box made of white wood.
Inside dimensions under cleats.
8" x 5 1/4" x 2 1/2"
Thickness of material.
Ends - 3/4" thick.
Sides, top and bottom - 5/8" thick.
Cleats - 1" wide and 3/8" thick.
Stock Bill.
1 P = 8" x 5 1/4" x 5/8" - bottom.
2 P = x x - ends.
2 P = x x - sides.
1 P = x x - top.
2 P = x x - cleats. .
Hardware.
Wire brads - 2" # 13 - to nail through ends.
Wire brads - 1 3/4" # 15 - to nail through sides
Wood screws - 3/4" # 7 - to screw on cleats.
Wood screws - 5/8" # 4 - to screw on hooks and eyes.
Hooks and eyes - 1 1/2" long - brass.
Number of square feet - board measure - ft.
6 1/2"
9 1/2"
3/8"
4 1/8"

FIG. 65

and the ends. Does this make a stronger box, than to nail the bottom to the lower edges of the sides and ends? Why?

The top is stiffened by two cleats, screwed on—not glued. Why?

Of what other use are the cleats?

Any one can nail together the pieces to form a box, and then plane it smooth and square, making quite a respectable box to look at, but your instructor is to mark your box immediately after it is nailed together, and before it is planed. Why?

No sandpaper is to be used on any of these exercises—the box, chiseling exercise, or joints—because sandpaper, though it smooths surfaces nicely, rounds over corners, spoils narrow edges and takes away the character of your work.

It is this character your instructor hopes to see shown: a smooth, shiny surface, made with a perfectly sharp plane-bit, set true in your plane—square edges—smooth, polished ends—corners sharp enough to cut your hands—nails set below the surface neatly—no hammer marks—screws countersunk flush with the surface without marring surface—and, lastly, the whole box clean and white.

To plane edges of two or more pieces when nailed or glued together.

Having nailed the ends of your box to the bottom, the edges must be planed slightly to receive the sides. Clamp the partly nailed box in vise as shown. Remembering that the throat of the plane does not extend clear across the plane, and that the bit is slightly rounded across the whole end, we cannot hold the plane as shown in Fig. 66 and take even a single shaving off, without

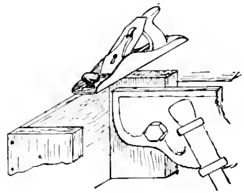


Fig. 66

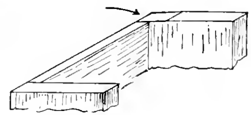


Fig 67

planing the end of the box end out of true, as the edge of the bit cuts nothing while the center is cutting off a whole shaving. Our box end would be slanted off as shown in Fig. 67.

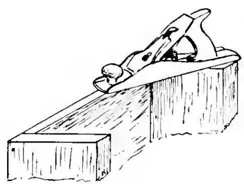


Fig. 68

The only way to plane edges of this kind (your glove-box later on) is to lay the back of the plane on one piece—the end of the box—and plane the other piece—the bottom—then lay the plane on the finished edge and plane the first piece. In this way only can you plane a square edge (Fig. 68).

Nails

Wire brads and nails are made by machines, which cut off the wire from a large reel, point it, and upset the end, making the head on the piece. Some manufacturers barb their nails, by making several sharp cuts on opposite sides of the nail near the head, throwing up the surface as in Fig. 69. This nail drives easily, and will not pull out.

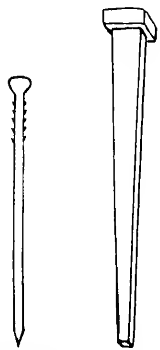


FIG. 69 FIG. 70

Wire brads with small heads and wire nails with large heads have taken the place of iron or steel cut nails for good reasons. Wire nails hold much better than iron cut nails, being thinner, and having a sharp point, and are of the same diameter the whole length, while a cut iron or steel nail is wedge-shaped (Fig. 70), and will therefore work back and out, and is blunt on the end.

The thin, sharp wire nail enters the wood with its sharp point merely separating and pushing back the fibers of the wood, which try to spring together again, thereby holding the nail more tightly, while the iron cut nail digs a hole out ahead of it with its blunt end, severing the fibers entirely, and being wedge-shaped soon works out.

Wire nails are bought and sold by weight, and as to size by length in inches, and size of wire according to the standard wire gauge. A 2-in. No. 10 or 12 wire nail is 2 ins. long and about $\frac{3}{32}$ ins. thick, while a $\frac{3}{4}$-in. No. 22 is $\frac{3}{4}$ in. long and hardly larger than a strong pin.

Screws

Wood screws (Fig. 71) are made entirely by machinery and have either round or flat heads. Some are made to screw in slowly and have a slowly advancing thread; this kind holds two pieces of wood together very firmly, but takes time to screw in. Never drive these screws; instead, a hole should be bored the size of the shank of the screw, and through the first piece of wood only. In the other piece of wood a much smaller hole is bored for the threaded part of the screw—in very hard wood the size of the diameter at the base of the threads—but in soft wood, much less.

Screws are also made to be driven, as a nail, and have but a few turns of the thread (Fig. 72). This kind is

used only in packing cases, and while it can be driven quickly, it holds but little.

Screws are bought and sold by the gross, in packages, and as to size by length in inches and size of wire. A 2-in. screw, No. 11, is 2 ins. long and about $\frac{3}{16}$ in. in

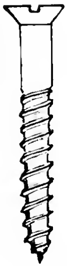


Fig. 71

Fig. 72

diameter, while a screw $\frac{3}{4}$ in. long, No. 3, is $\frac{3}{4}$ in. long and only about $\frac{3}{32}$ in. in diameter.

Notice the difference in the gauge of wire, for brads and screws.

Wire No. 22 for nails would be only as thick as a strong pin, while No. 22 wire for screws would be as thick as your small finger. Wire for a No. 3 nail would be over $\frac{1}{4}$ in. thick, while wire for a No. 3 screw would be only about $\frac{3}{32}$ in. thick.

Screw Eyes

To find the position of the screw eyes for the hooks, in the ends of your box, set your dividers to measure the exact distance between the center of the hole for the screw and the center of the hook (Fig. 73). Let fall a

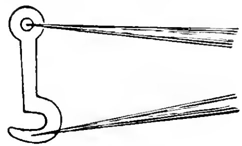


Fig. 73

perpendicular line from the center of the end of the cover of your box, and on this line lay off the distance found, from the same center. A small hole should be bored for the eye with a brad-awl, the brad-awl being used later to screw in the eye (Fig. 74).

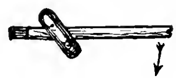


Fig. 74

Chiseling Exercise Made of White Wood (Fig. 75)

The lumber supplied by your instructor is large enough to allow only for careful truing up.

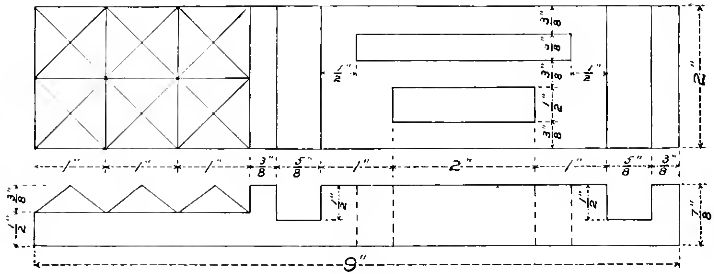


Fig. 75

Follow the rule for planing to dimensions.

The ends, being only 2 ins. wide, will be hard to plane square. Reverse your plane and plane from both edges.

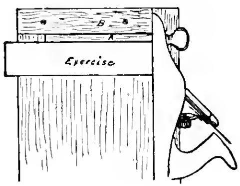


Fig. 76

Narrow ends may also be planed in the bench hook or chiseling board, by arranging it as shown in Fig. 76—the narrow strip, A, being necessary, as the end of your bench-hook, B, is soon sawed out of true.

Mark out the square grooves and mortises and the square shoulder next to the pyramids with knife and try-square and a sharp gauge, marking out the mortises on both sides of your exercise.

To mark out the base lines of the pyramids, or the apexes with knife or gauge, would mar the pyramid, as the wood is to be cut away on a slant, and not straight in as a knife cut or gauge line is made. Chamfers or bevels will always have to be marked out with a lead pencil, sharpened to a chisel point (Fig. 77).

Show to your instructor.

Notice that the pyramids are to be made first as roofs —across the wood. Why?

Lay your wood in bench hook and saw to knife lines

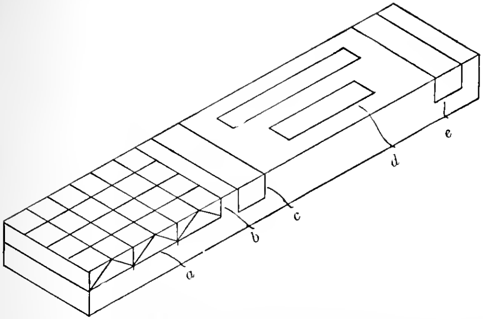


FIG. 77.—*a*, lead pencil lines; *b*, knife line; *c*, knife lines; *d*, gauge and knife; *e*, knife line

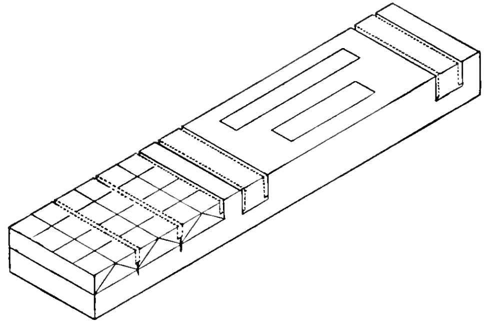


FIG. 78

in square grooves and the square shoulder next to pyramids; also saw a kerf part way down between the pyramids, that the chiseled shavings may break off (Fig. 78).

Turn on edge and pare down to the bottom of the square grooves (Fig. 79). Do not touch shoulders.

Notice the clean knife line around the edges of groove.

Clamp in vise or tail screw, and with mallet and chisel cut out the three double pyramids across the wood, chiseling always down the sides of the pyramids, and not across horizontally, or lengthwise with the grain. Notice the clean knife line around the edges of the square shoulders (Fig. 80).

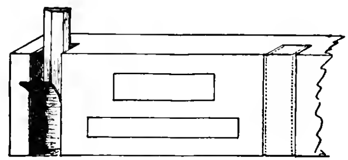


FIG. 79

Mark the pyramids on the slanting sides (Fig. 81), saw a kerf down the center and chisel down as before—and not with the grain.

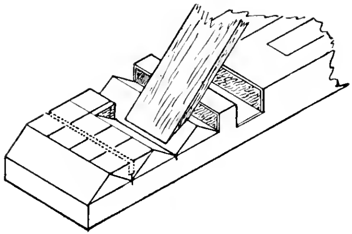


Fig. 80

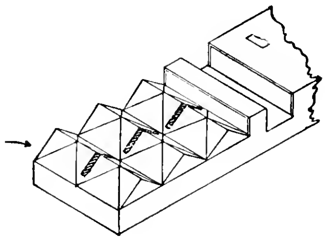


Fig. 81

To Chisel Shoulders

Take any practice piece, mark across the face and down both edges with knife and try-square. With the chisel held perpendicularly, always, give a side movement to the downward cut, making a shearing cut, taking care not to mar the smooth knife lines (Fig. 82).

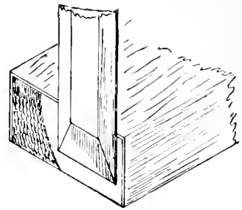


Fig. 82

Your instructor must see knife lines around edges of all shoulders.

Mark the mortises with both knife and gauge on top and bottom sides of the exercise, then chisel a full $\frac{1}{8}$ in.

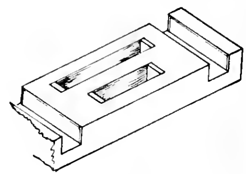


Fig. 83

away from both ends, chiseling from both sides of the wood, truing up the $\frac{1}{8}$ in. ends after the mortises are cut through and through (Fig. 83).

Your instructor must see knife lines on ends and edges of your mortises.

Joints

The simplest and most widely used of all joints, for heavy timbers as well as lighter work, is the half-lap joint—either a corner half-lap (Fig. 84), or a lap within the length (Fig. 85).

It is used in house framing, in lapping over length-

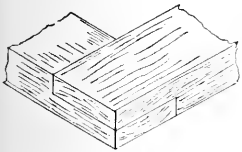


FIG. 84

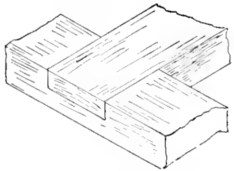


FIG. 85

wise in ship building, making a simple scarf joint (Fig. 86), and in the crossing of heavy timbers (Fig. 87).

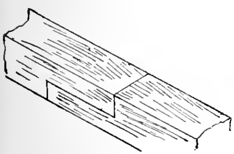


FIG. 86

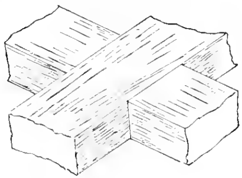


FIG. 87

Middle Half-lap Joint

Make a middle half-lap joint of the dimensions given (Fig. 88). The wood will be of sufficient length to make the two parts of the joint, and should be planed in one piece, to the exact width and to a full thickness ($\frac{1}{32}$ in. over), to allow for planing up both faces, after the completed joint has been shown to your instructor.

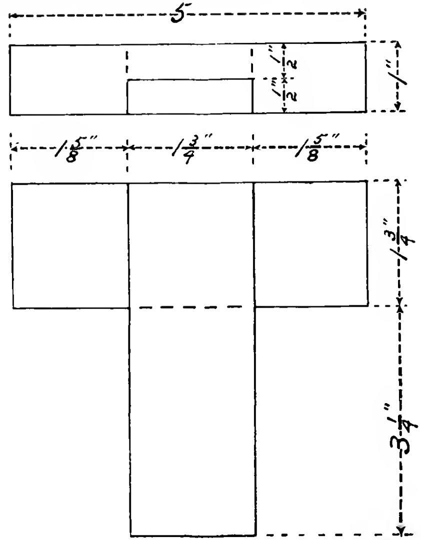


FIG. 88

Parts of the joint that do not fit cannot be forced to fit in any way known, without marring the parts, so

no hammering together of the fitted parts, or screwing in the vise or hand screws will be permitted.

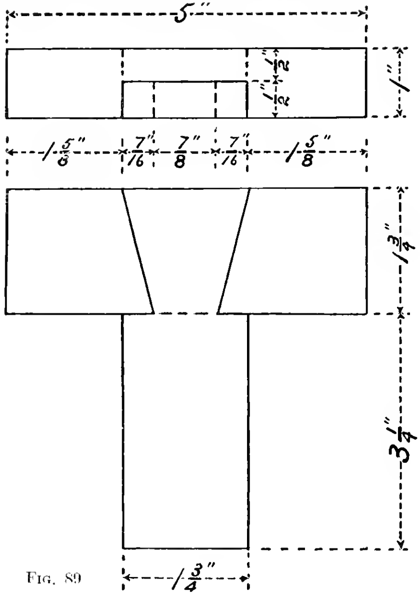


Fig. 89

Middle Half-lap Dovetail Joint

The same kind of construction—half-lapping—but a stronger and safer joint, with one of the timbers dovetailed (Fig. 89). Plane your stock in one piece to exact width and full thickness ($\frac{1}{32}$ in. over). Make the tail first and mark off mortise from the tail. Will it be good practice to make the tail, as in Fig. 90, then turn it on edge and pare half away and break out the lower sharp corner, as in Fig. 91?

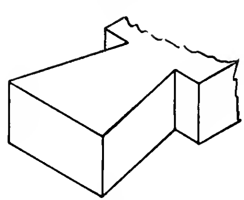


Fig. 90

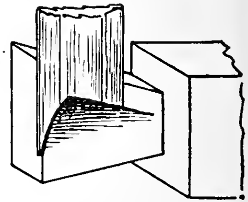


Fig. 91

Or cut it half away first (Fig. 92), then mark out the tail with knife, saw the shoulders, and chisel on chiseling board (Fig. 93).

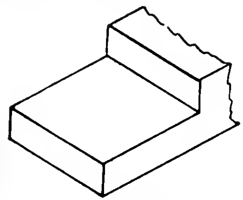


Fig. 92

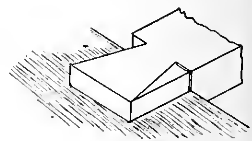


Fig 93

Mortise and Tenon Joint

The next most widely used joint is a mortise and tenon joint, made up of a mortise or hole (Fig. 94) and a tenon or tongue to fit the hole (Fig. 95).

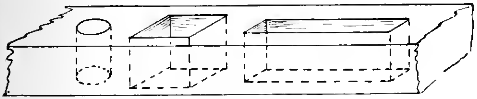


Fig. 94

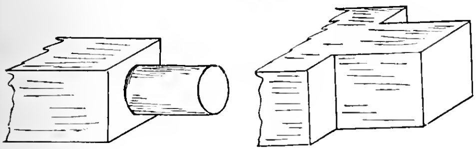


Fig. 95

The tenon or tongue often slides in at the corner, making a slip mortise and tenon joint—called also a tongue and groove (Fig. 96).

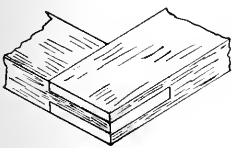


Fig. 96

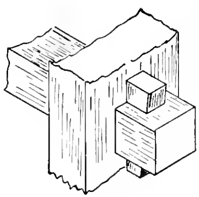


Fig. 97

Or, the tenon often extends through and beyond the mortise, and is keyed on the outside (Fig. 97).

Again, the tenon is half dovetailed in and keyed (Fig. 98).

Or, the tenon is split with the saw, and glued wedges driven in, after the mortise has been lengthened on the lower side. Door and window frames for houses are made in this way (Fig. 99).

Note.—Joints are not to be glued.

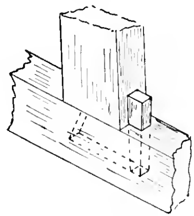


Fig. 98

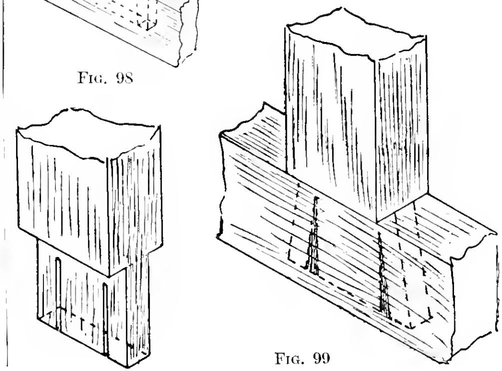


Fig. 99

Through Mortise and Tenon Joint

The tenon extends through and beyond the mortise ¼ in. Gauge and knife all lines (Fig. 100). The tenon must not bind or rub the sides of the mortise on coming

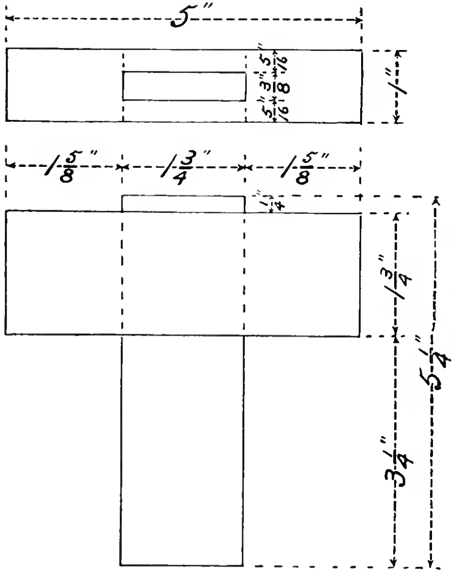


Fig. 100

through, or the end of the tenon will show the bruised and marred surface. Neither must the tenon wabble sidewise or lengthwise in the mortise.

Pare down the sides of the tenon, with the wood held on edge on bench hook (Fig. 101).

Lay out mortise with knife and gauge on both edges of wood, chiseling from both edges, and ⅛ in. from both ends of mortise, to allow for prying out shavings and truing up ends. In paring down the sides of the tenon or mortise, the wood may be held in the vise, and both

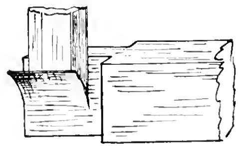


Fig. 101

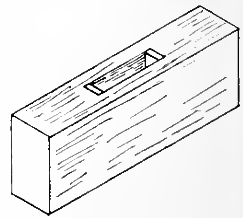


Fig. 102

hands used to hold the chisel, provided all chiseling is done across the grain—never with the grain, for fear of chiseling under the marked surface (Fig. 102).

To Cut Tenons in Hard Wood

It is impossible to pare down the sides of the tenon as in the softer pine or poplar, so these tenons must be

Note.—Joints are not to be glued.

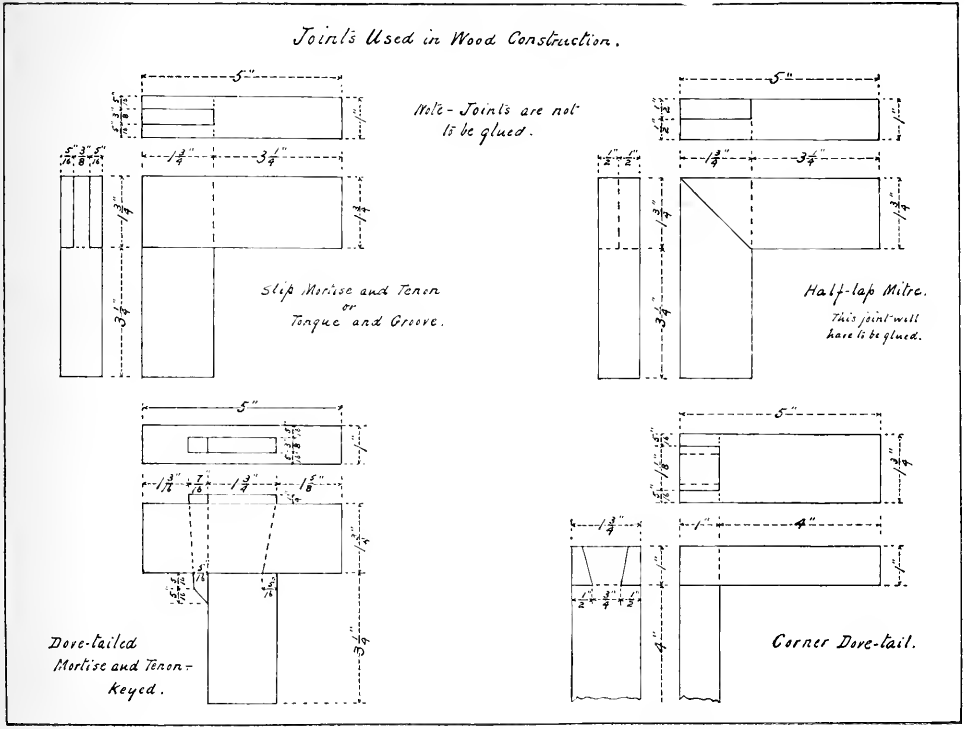

Joints Used in Wood Construction.
Note - Joints are not to be glued.
Slip Mortise and Tenon or Tongue and Groove.
Half-lap Mitre.
This joint will have to be glued.
Dove-tailed Mortise and Tenon - Keyed.
Corner Dove-tail.

FIG. 103

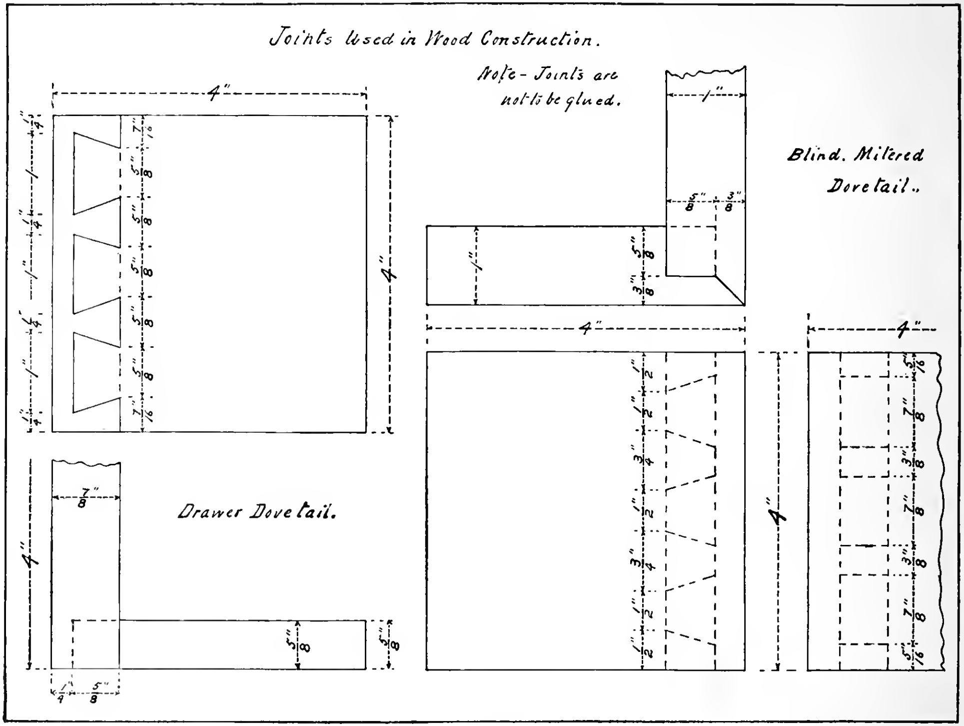

Joints Used in Wood Construction.
Note - Joints are not to be glued.
Blind. Mitered Dovetail.
Drawer Dovetail.

FIG. 104

sawed carefully to gauge and knife lines (Fig. 105), with a sharp tenon saw, or back saw.

Clamp wood in vise at such an angle as to be able to see gauge lines on end and edge of piece, and saw to both lines (Fig. 106).

Swing wood over in vise until other edge of piece can

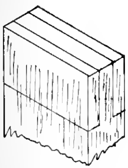


Fig. 105

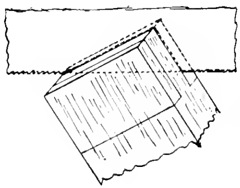


Fig. 106

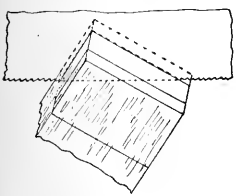


Fig. 107

be seen, and saw to gauge lines, using kerf already made in end as a guide (Fig. 107). Finish by clamping wood straight up and down in vise, and saw to bottom of tenon.

Table Leg Joints, Showing Top Screwed On

One rail doweled in.

Other rail mortised and tenoned.

Rails bored for screws (Fig. 108).

To mark out for dowels, drive three small brads in centers on end of rail, cut off brads to project $\frac{1}{16}$ in. only, and push rail against table leg in proper place.

This method is best where legs or rails are sawed at an angle or are curved, as in chairs.

Two short mortises are made in leg to receive the tenons, instead of one long mortise, that the connecting $\frac{1}{2}$ in. of wood between mortises may prevent the leg from splitting or bending out, when tenons are driven in.

Table tops are screwed on, not glued. A large slanting hole is bored in the rail, as at A (Fig. 109), leaving a shoulder for head of screw.

To Set Bevel to 45°

Plane the edge of any board straight and true. With try-square and knife, draw a line A at right angles to edge. With rule, mark off on line A and on edge of board, equal distances from right angle, 2 ins.—2 ins. or 3 ins.—3 ins., making two adjacent sides of a square. With handle of bevel held firmly against edge of board, as shown in Fig. 110, move the blade of bevel until it just touches points marked off on line A and edge of board, equally distant from right angle. Screw up set screw of bevel gently, and blade will mark on one side of handle 45°, and on other side 135°.

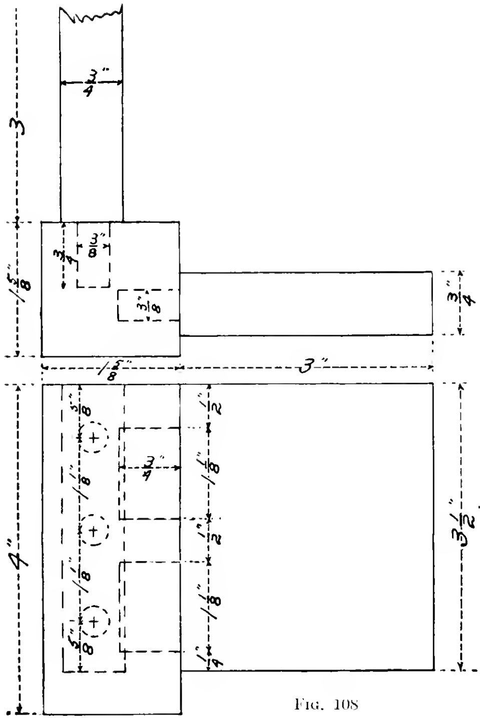


FIG. 108

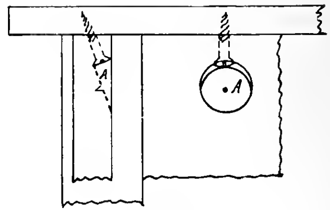


FIG. 109

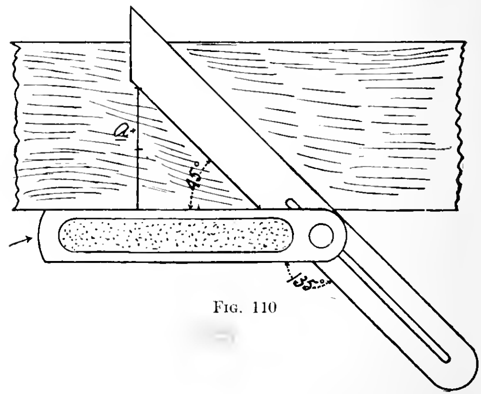


FIG. 110

The blade, made to reach from one corner of an imaginary square to the opposite corner with the handle of the bevel parallel to one side, cuts these two corners, or right angles, measured by 90°, into halves, measured by 45°.

A simpler method is to use the large carpenter's square as the adjacent sides of an imaginary square, and with the handle of the bevel held firmly against one side of the square, move the blade until it just touches points equally distant from corner of square: 2 ins.—2 ins.; 3 ins.—3 ins. (Fig. 111).

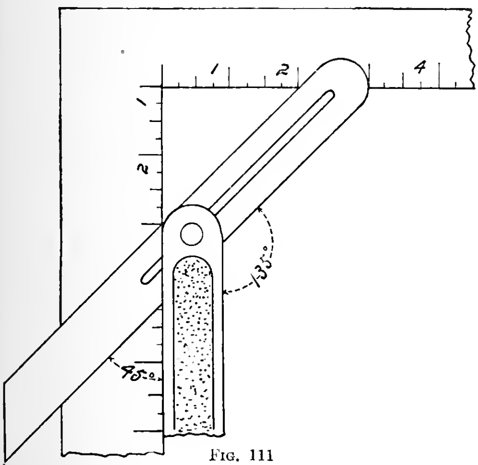


Fig. 111

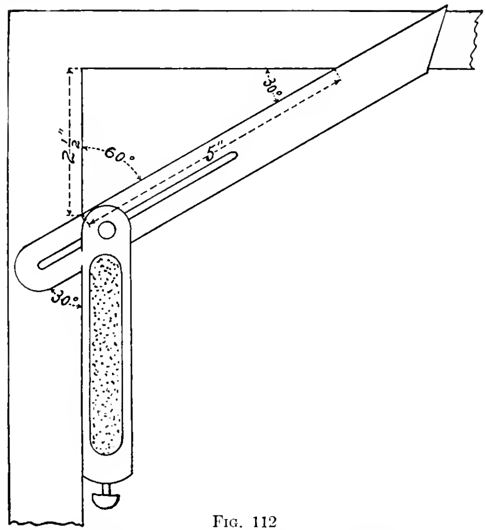


Fig. 112

To Set Bevel to 30° and 60°

In any right-angled triangle, if the hypotenuse is twice the length of the short side, the angles adjacent to the hypotenuse will be measured by arcs of 30° and 60° (Fig. 112).

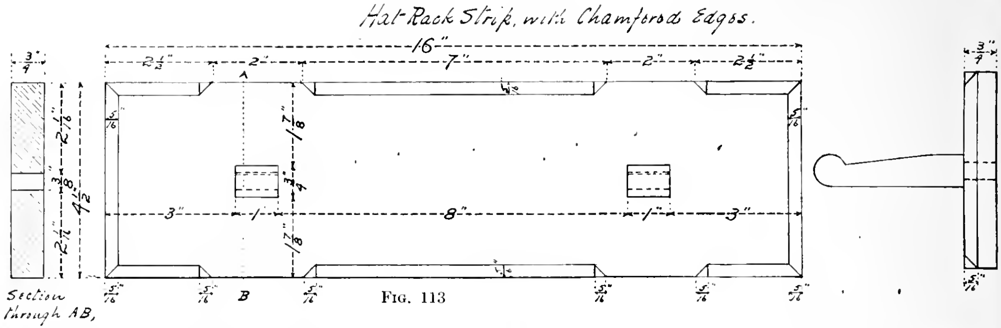


FIG. 113

Mark off on the blade of the bevel any distance, say 5 ins. Mark off on one side of large carpenter's square $2\frac{1}{2}$ ins.—just one-half the distance marked off on the blade, which distance is to be the length of the hypotenuse of the right-angled triangle.

Hold the handle of the bevel firmly against one side of the large square, with the blade just touching the point marking $2\frac{1}{2}$ ins. from the corner right angle.

Swing the blade until the point marking the distance 5 ins. just touches the other side of the large square.

The hypotenuse of the right-angled triangle is then just twice the short side, making the angles 30° and 60° wide.

Hat Rack Strip with Chamfered Edges (Fig. 113)

Chamfers may be rounded, or hollow, or a slant of 45°, or any other bevel, and are used to finish off sharp corners (Fig. 114)

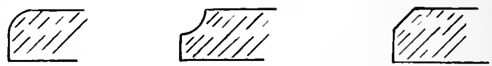


FIG. 114

Construction. Plane the strip to exact dimensions, square and true.

With rule and sharp lead pencil, find the position of mortises, also the length of chamfers along edges.

With knife and gauge and try-square, lay out mortises on face of strip, turn over and lay out mortises on other side with same set of gauge (Fig. 115).

When chiseling the mortises, cut a full $\frac{1}{8}$ in. away from

both ends of the mortise, chiseling from both sides of the wood, truing up the $\frac{1}{8}$ in. ends after the mortises are cut through and through. This method prevents marring the ends of the mortises, and the perfect fit of the tenons on hat pins (Fig. 116).

Chamfers cannot be gauged, for fear of marring the surfaces, *a–a* (Fig. 117), showing the scratches made by the gauge, which are not removed by the chamfer.

With rule and very sharp lead pencil, measure off $\frac{5}{16}$ in., the width of the chamfer, on face and edges, making several short dashes at each measurement. With a straight-edge make a light line connecting the dashes. Or with the pencil held in the fingers, make a finger gauge, and connect the dashes (Fig. 118).

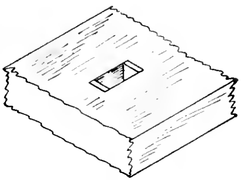


Fig. 115

The end chamfers may be planed off, moving the plane across the end of the strip, in the direction of the arrow (Fig. 119), holding it to cut at 45° with the grain of the wood, making a smooth, shearing cut. Always plane on top of the ends of the fibers—toward the ends, not up against them.

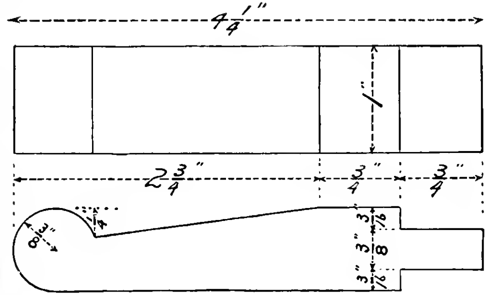


Fig. 116

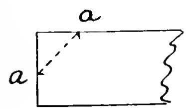


Fig. 117

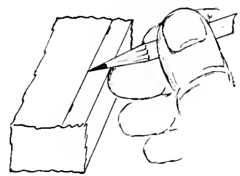


Fig. 118

The edge chamfers are to be chiseled, holding the chisel at an angle, to make a shearing cut, the straight back of the chisel helping to follow the line, and make a

true surface. The grain of wood is too crooked and unreliable to cut altogether with the grain. The chisel, held as shown (Fig. 120), cuts partly across and partly with

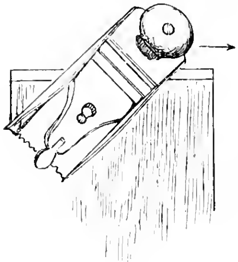


Fig. 119

the grain, the flat back helping to guide the cutting edge.

It is better practice to cut the ends of the chamfers

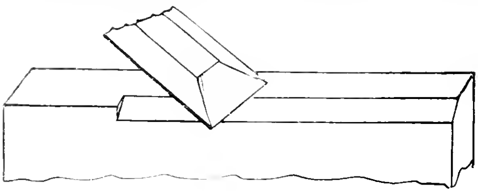


Fig. 120

down straight, at first, finishing the chamfer true and smooth, then cut down the slanting ends (Fig. 121).

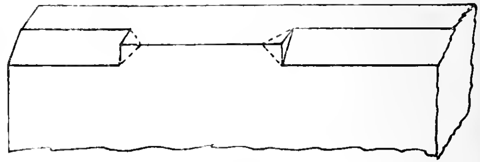


Fig. 121

Shaping the Hat Pins (Fig. 116)

Plane the wood for the hat pins in one piece—9 ins. long, 1 in. wide, and $\frac{3}{4}$ in. thick. Saw into two pieces of equal length, and lay out the tenons $\frac{1}{16}$ in. longer than $\frac{3}{4}$ in., with knife and try-square and gauge, gauging around

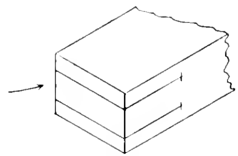


Fig. 122

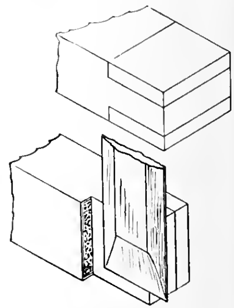


Fig. 123

the end of the piece (Fig. 122) for the tenon, and knifing the shoulder with knife and try-square. Knife the gauge

lines also, saw the shoulders close to the knife line, hold the piece on edge on bench hook, and pare down the tenon as shown in Fig. 123.

Notice the knife line around the shoulder.

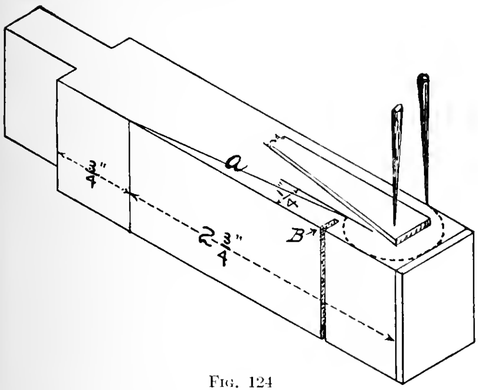


Fig. 124

In laying out the curved end of the pin, care must be taken not to mar the edge of the piece with the point of the dividers, as no work showing a center hole will be accepted by your instructor. Split from a practice piece a thin chip, on which to rest the point of the dividers. As the wood is $\frac{3}{4}$ in. thick and the dividers are set to $\frac{3}{8}$ in., the position of the chip, on which rests one leg of the dividers, is easily found (Fig. 124). Draw with lead pencil a light line $\frac{1}{4}$ in. from top face of pin, and continue the circumference of the end circle or curve until it intersects this line. From the point of intersection draw a line A to the end of the $\frac{3}{4}$ in. plane or flat place on the top face of the pin. Knife the line A. Saw down at B, $\frac{1}{8}$ in. or $\frac{3}{16}$ in. only, that the chips may break away when chiseling (Fig. 124).

With the chisel held perpendicularly, pare down the

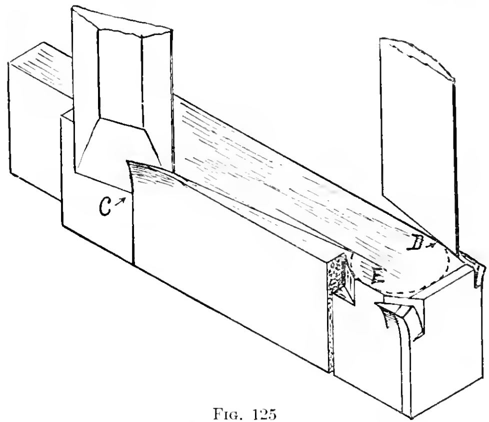


Fig. 125

upper face of the pin, beginning to chisel at C (Fig. 125), that the chips may break away with the grain. For the same reason begin to chisel at D and at E. Chisel from both sides of the pin toward the center, paring

around the circular end, leaving short, straight cuts, as shown, which must be carefully smoothed out by paring over and over, until a smooth curve is secured (Fig. 126).

No sandpaper or file is to be used until your instructor

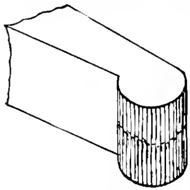


FIG. 126

measures and tries each piece. The pin may then be beveled off on each side from the $\frac{3}{4}$ in. plane or flat place, reducing the width of the curved end to $\frac{1}{2}$ in. (Fig. 127).

The pins are to be glued in. Make a small paddle with which to glue the sides of the mortises—do not

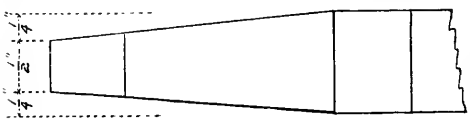


FIG. 127

glue the tenon—glue the shoulder of the tenon only, and drive the pin down, placing a small block on the end of the pin to receive the blows of the hammer or mallet, also place a piece of newspaper on the bench to receive the drops of glue. The bench top must be kept clean.

With a sharp chisel, cut away any glue around the pin, and plane off the extra $\frac{1}{16}$ in. of tenon on the back of the strip.

Sandpaper carefully with No. $\frac{1}{2}$ sandpaper, held in the fingers on a small block of wood, sandpapering with the grain of the wood always.

Fill with white filler and wax. Screw into top edge two screw eyes, boring first with brad-awl.

Suggestions for Your Conduct in the Shop

Your place is at your own bench always.

Should you leave your bench to show your work to your instructor, or to go to the machines, be careful, in passing, not to interfere with other men. Beg his pardon, or excuse yourself, if you should do so.

Your bench is made to work at—not to sit on or lounge on. Stand at your bench.

Should your work be interfered with by the stopping of the motor, or the absence of your instructor, or for any other reason, stand at your bench; remember your place is at your bench.

Permission must be asked, at all times, to leave the shop.

Quiet talking is permitted only as long as it does not interfere with your work. A busy, thoughtful workman has no time to talk, excepting a pleasant nod, or "good-morning" to his class-mates.

Show your good breeding by your quiet, gentlemanly conduct at all times, even when "things go wrong," and a hard piece of work has to be done over. Conquering your impatience and your bad temper is better work than making a perfect exercise.

Congregating at the grindstones or the band saw will not be permitted. If you must wait your turn, wait at your bench, then move up not closer than six feet from grindstone or band saw. Crowding a man at the machines, or distracting his attention, or interfering with him in any way, is dangerous, and will not be allowed.

Good spirits—better work. Be pleasant and keep so, not only for the help it gives you in accomplishing your work, but for the sake of your class-mates and your instructors.

SUGGESTIVE QUESTIONS

Sawing

1. Give the correct name of every tool in bench and drawer.
2. What is meant by the pitch of a saw tooth?
3. How much pitch has the tooth of a cross-cut saw for general work?
4. Prove, by a sketch, that a saw tooth with pitch will cross-cut more easily than one without.
5. What is meant by setting saws? Are saws generally set? Why?
6. What is a saw kerf? Must it be considered?
7. Why file a cross-cut saw from the handle to the point?
8. Are all the teeth filed from one side? Why?
9. How many points to the inch should a cross-cut saw have? A saw for general use?
10. Has the rip saw tooth any pitch? Why not?
11. Why has a rip saw larger teeth than a cross-cut?
12. How is a rip saw filed, and like what other tool does each tooth become?
13. At what angle should the rip saw be held to cut best?
14. How many points to the inch should a rip saw have, to rip well in medium and hard wood?
15. What kind of saw is the back saw, generally? Why is it called a back saw, and for what special work is it used?
16. How many points to the inch should it have?
17. How is the size of saw teeth indicated on your saws?
18. What kind of teeth on a band saw? A scroll saw?
19. Why should a knife be used always to lay out work?
20. Should heavy gauge lines ever be used to lay out work?
21. Is gauging across the grain good practice?
22. Should chamfers or bevels be gauged?
23. Give two reasons for using a mallet on chisels.
24. How do you set a tee-bevel to an angle of 45°? To 60°?
25. How do you lay out a hexagon and an octagon on a square top of given dimensions?
26. What is meant by the swing of a bit-brace?
27. How is the size of the auger-bits shown?

Grinding

28. Grindstones run at 500 ft. circumference per minute. At how many revolutions per minute would you run a 42-in. stone?
29. How does a grindstone get dull?
30. Why use water on a grindstone?
31. Will the grindstone cut faster when running toward you or away from you? Why?
32. Which is the safer side at which to grind?

Sharpening

33. Why use oil on an oil-stone?
34. Does your oil-stone get dull?
35. Describe the best way to hold your plane-bit or chisel on the stone. Will one hand hold the tool properly?
36. Should you hold the tool so high as to make a second bevel? Why?
37. How long should you rub the tool on the oil-stone?
38. What is a feather edge?
39. Describe carefully how the feather edge is removed.
40. Will whetting the bit or chisel on a block of wood to remove the feather, make a sharp tool? Why?

PLANES

41. How do you set your plane?
42. Should the plane-bit be perfectly straight across? Why not?
43. What is the use of the cover or breaker? Illustrate by sketch.
44. How far back from the end of the bit should the cover or breaker be screwed for cross-grained or knotty wood?
45. Can you name planes which have no covers or breakers? Do they cut as smoothly?

To Plane a True Face

46. Explain how to plane a true surface.
47. Show by a sketch the position of the plane and the pressure applied as you begin your shaving and end it.
48. When is a board in wind? Name two ways of trying it to get it out of wind.

To Plane Edges Square with Marked Face

49. Explain, and show with sketch, how the slightly rounded end of the plane-bit will take off the higher side of the edge, by merely moving over the whole plane to the higher side.
50. Should the bit ever be pushed over, out of true, by the lever, to plane edges? Why?

To Plane Ends

51. Explain, carefully, the proper way to plane ends.

Marks and Chatters on Surfaces

52. What are chatters, and how caused?
53. What is the matter with the plane-bit when it leaves a little round bead on the surface of the wood?

54. What causes small hollows or scratches to be left in the board?
55. Does a great pile of shavings always show a fast, good workman?
56. Give the rule for planing to dimensions.
57. Why begin on the larger surface first?

Nails

58. How are wire nails made?
59. Explain fully why they hold so much better than cut nails.
60. How are they sold? How is size shown?
61. What is a cut nail? What sensible objection is made to the blunt end and the wedge-shaped side?
62. How are cut nails sold, and how is size shown? How did this originate? Size of tacks?

Wood Screws

63. How is the size of screws shown? How are they packed?
64. State carefully the difference in gauge of wire for screws and wire nails.
65. What is a shearing cut?
66. Why is such a cut so much smoother than a straight downward cut?

Joints

67. What is the simplest and most widely used joint in all construction?
68. Make a sketch of each of four ways of using this joint.
69. Make a sketch of this same joint, but stronger and safer.
70. What is a mortise-and-tenon joint ?
71. Make a sketch of a slip-mortise-and-tenon joint—also called a tongue and groove, a keyed mortise and tenon, a wedged mortise and tenon.
72. To what very common use is the wedged mortise-and-tenon put?
73. Make a sketch of a half-lap miter joint.
State where this joint could be used to advantage.
74. Sketch a corner dovetail.
75. Sketch a drawer dovetail.
Explain why this joint has been used for so many years on drawer fronts.
76. Describe a blind mitered, dovetailed joint.

WOOD TURNING

The Lathe

Figure 128 shows a 10-in. speed lathe with its countershaft. The 10-in. measures the diameter of the largest pulley or piece of wood that can be turned. This measurement is taken from the center of the spindle to the bed, 5 ins.

The bed is planed true on the upper surface, and has two ways or shears, on which the rest and tail stock slide.

The head stock supports the split boxes, in which runs the live spindle with the cone pulley fastened to it. This spindle is threaded at the right end to receive the face plate, and has a hole bored entirely through it from end to end, to admit of inserting a rod to knock out the tapering live center or spur center, so called because it turns the wood by having its spurs driven into one end of the wood (Fig. 129).

The split boxes are adjusted by means of caps, into which are screwed the oil cups.

A set screw with a set nut to clamp it, is provided at the left end box, which takes up any lateral motion caused by wear of the spindle.

The tail stock supports the dead spindle which has a tapering hole to receive the dead center. There are two kinds of dead centers—the point center (Fig. 130), which is unsafe for wood turning, as the friction between the wood and the point is so great, even when the wood is oiled, as to burn and char the wood, allowing it to fly from the lathe; and the cup center (Fig. 131), which has a true, flat bottom or back, inside of a rim $\frac{1}{16}$ in. or $\frac{1}{8}$ in. high, and $\frac{1}{2}$ in. or more in diameter, thereby holding a whole half inch of the wood, instead of just a point, and without the pushing friction of the point center. The dead or tail spindle does not revolve, but slides in and out on the tail stock and a grooved way, by means of a screw, with a hand wheel or handle at the right end. The tail spindle is provided with a clamp lever, which must be carefully screwed up to clamp the spindle when the wood is revolving.

The slide rest consists of a lower slide running on the ways or shears, and an upper slide containing the post, to support the tee-rest, which is adjusted by a set screw. The upper slide is also provided with a tee way or groove to admit the head of a long bolt, running down through the lower slide and also through the bed of the lathe, and clamped on the under side, thereby holding both parts of the rest to the bed in any position required.

Countershaft

The countershaft receives the power from the line shaft, and delivers it to the lathe. This countershaft

is most necessary, enabling you to stop your machine, while the next lathe or all other lathes continue to run.

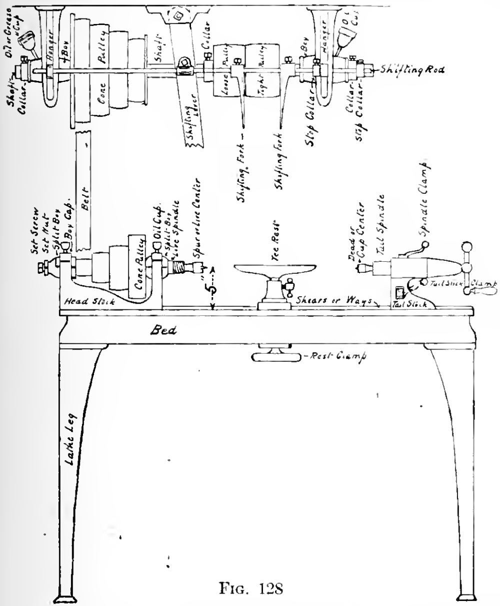
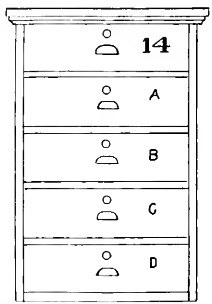


FIG. 128

This is done by making one of the two similar pulleys on your countershaft a loose pulley; that is, a pulley that merely runs on your shaft without turning it, and by throwing your belt on this pulley by means of the shifting lever, the power is taken away from your machine, allowing it to stop immediately.

The countershaft runs in boxes, held in place by means of two or more hangers (Fig. 132). Fastened to the countershaft is the driving or tight pulley, the same size as the loose pulley, and the cone pulley, with its largest end over the smallest end of the head-stock cone, thereby giving you greater speed at your lathe. The largest diameter of the counter cone is about 12 ins., and the countershaft runs 500 revolutions a minute. The smallest diameter of your head-stock cone on lathe is about 2 ins. How fast will your lathe run if the belt is on the largest and smallest steps of these cones?

Tool Case



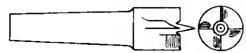


FIG. 129

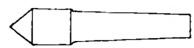


FIG. 130

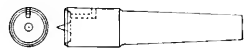


FIG. 131

Each hanger of the countershaft has a projecting arm, to support the shifting rod, which is moved in either direction by means of a shifting lever, which is convenient to and is moved by your hand. To shift the belt, there are fastened to the shifting rod two shifting forks, coming down on either side of the belt, also two stop collars, to limit the motion of the rod when moved by the shifting lever.

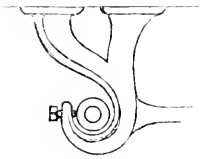


Fig. 132

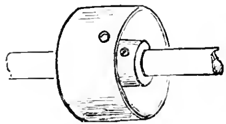


Fig. 133

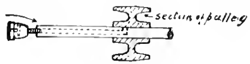


Fig. 134

Oiling the Loose Pulley

The loose pulley, running on your countershaft, must be oiled frequently, or it will stick tight, and turn your lathe. A hole is bored in the hub of the wheel for this purpose (Fig. 133), and also in the rim of the pulley, down through which you may push the spout of your oil-can. Another method of oiling the loose pulley is to drill a hole into one end of the shaft, as shown in Fig. 134, into which a grease cup is screwed. This grease cup has a cover or cap made to screw down, and by turning the cover a piston, fastened to the cover, pushes the grease forward into the hole. Another and better method is to have the hub of the pulley made large enough to contain a bushing or collar (Fig. 135), on which the pulley runs, and also a chamber for grease. The chamber is filled with grease, the bushing is forced into the hub of the pulley, and by means of holes in the bushing, the grease reaches and oils the shaft. Such pulleys need grease only once or twice a year.

Loose pulleys are frequently made much smaller than the tight pulley, with a slanting edge or way (Fig. 136), up which the belt will run when the shifting lever is moved. The loose pulley may be made $1\frac{1}{2}$ ins. or 2 ins. less in diameter, thereby loosening the belt nearly four inches in a 10-in. and 12-in. L and T pulley, thus taking the strain of a heavy, tight belt off the loose pulley, reducing the friction, and the necessity for frequent oiling. The

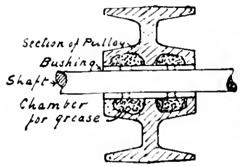


Fig. 135

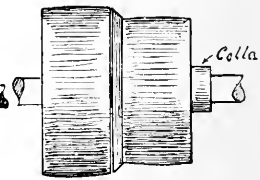


Fig. 136

Wetherby, Rugg, and Richardson lathes have no loose pulleys. The countershafts of these lathes are made of two short shafts, each piece revolving in two boxes. On one piece is fastened the cone pulley and driving pulley corresponding to the tight pulley on the other lathe counters; on the other piece is fastened a single pulley, the loose pulley of the other counters. The belt being thrown on this pulley, ceases to drive the lathe, as it is on a separate shaft from that on which the cone and driving pulley are fastened.

All these devices have been explained to show the thought that has been given to the loose pulley by manufacturers. Loose pulleys are always causing trouble, and must be cared for, and oiled, and watched constantly.

Why could not a small oil cup, carefully filled, be screwed into the oil hole of the hub of a loose pulley, and give good service? Explain to your instructor.

Care of the Lathe

Oil your lathe before starting, every day.

The lathe is to be brushed off and cleaned thoroughly, at the end of each shop period; the "general" tools are to be carefully returned to their places in the tool drawer of the case, and your own "individual" tools locked in your drawer.

Your instructor will take apart the head stock of a lathe, showing you how to remove the caps, the boxes, the spindle; and how to clean the boxes and spindle with waste and oil. In no case is your lathe to be taken apart without the permission of your instructor, and in no case is the lathe to be started up after taking apart and cleaning without first having been examined by your instructor, to see that the caps are screwed down just far enough to permit the spindle to run easily and freely, and still not rattle in the boxes. A hammer or monkey wrench, or any piece of iron, is never to be

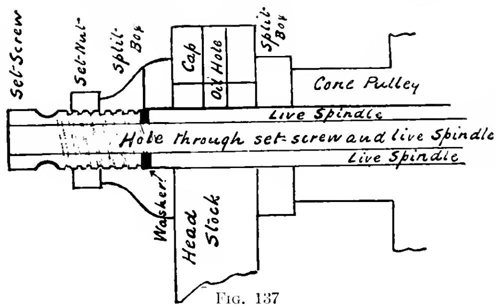


FIG. 137

used to pound apart the boxes, or a screw-driver to pry them apart, or to pound or pry any part of a machine. Use instead a piece of wood.

The set screw at the left end of your lathe (Fig. 137) is to be unscrewed with your hand only (do not use a monkey wrench), and fastened with the set nut, leaving the spindle quite free to run as long as the wood is held between both live and dead centers. When doing face-plate work the set screw, pushing the thin washer

at the right end, is gently screwed against the end of the spindle, and fastened with the set nut. If the box gets hot from the friction, or if the lathe does not run full speed because of the friction, loosen both set nut and set screw a quarter turn.

Your instructor must be asked to examine your lathe if it does not run easily, or if the boxes get hot.

Speed of the Lathe

The lathe spindle has a speed of 3,000 revolutions, when the belt is on the smallest step of the lathe cone. This speed is adapted for work up to 2½ ins. or 3 ins. in diameter, the second or third speed for work up to 5 ins. or 6 ins. in diameter, and the slowest speed for pieces above 6 ins. No particular speeds can be given for lathes, because of the nature of wood, higher speeds being required for soft wood than for hard. For instance, a 3-in. diameter cylinder of pine could be turned at a speed of 2,800 or 3,000 revolutions per minute, and make smooth, fine work, without injuring the tool; but a cylinder of equal size, of white maple or oak, turned at such a speed, would burn the wood and draw the temper of the turning chisels. In turning cylinders from rough stock that cannot be centered truly, or face-plate work, such as patterns glued up of many pieces and therefore not balanced, it is safer to run the lathe at a slow speed, until the work is centered or runs true—then increase the speed. The centrifugal force on a piece of work revolving rapidly is very great, and if the work is but a very little unbalanced, it will be thrown from the lathe, or the lathe itself will be made to vibrate or shake so much as to make any attempt to work on it useless.

Belts

The best belt is cut from the back of the hide, and is in short lengths; hence the name, short-lap belts. These pieces are fastened together in different ways. After first beveling off the ends of the belts, that the two ends may lap over without increasing the thickness, the parts are sometimes riveted together. A better method is to glue the beveled ends together, with glue or cement prepared for the purpose.

Your lathe belts will become slack, through the stretching of the leather, and you yourself, with the aid of your instructor, and with his permission at all times, must cut and take up the belt.

Gluing requires too much time, excepting on large belts, running heavy machines, and riveting is not good practice, so your belt will be laced with either raw-hide belt lacing, or with wire lacing, or the two ends will be held together with belt hooks.

To use the wire lacing, cut your belt square across, after marking with knife and try-square, cutting out the amount your instructor thinks necessary, then follow the directions which accompany the wire lacing outfit, taking care not to cross the lace wire on the inside of the belt, as the pounding of the belt against the pulley will very soon cut the crossed wires in two. The same rule, for the same reason, holds good in the use of raw-hide belt lacing—never cross laces on the inside of a

belt. To tie a raw-hide belt lace, make an extra hole or slit, narrow and short, with the small blade of your knife, as at A, A (Fig. 138); pull the lace through and

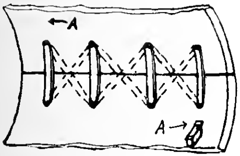


FIG. 138

FIG. 139

FIG. 140

hook it by cutting a little gash (Fig. 139) in the edge of the lace, which will slide back against the belt, and prevent the end slipping through.

Belt-hooks are metal hooks (Fig. 140) made of soft iron or steel, and are of different lengths for light or heavy belts. They are most convenient, as the ends of

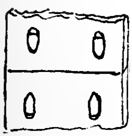


FIG. 141

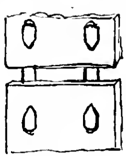


FIG. 142

the belts can quickly be hooked together, but they are noisy, as they give out a sharp click every time they hit the pulley, and the continual pounding against the pulley wears the hole in the belt larger and larger, until the hooks are torn out. If used at all, the holes for the hooks must be punched with the belt punch a distance back equal to half the extreme length of the hook, that the ends of the belt may be held firmly together, as shown in Fig. 141, and not as in Fig. 142.

The short ends of the hooks are always to be on the inside of the belt, against the pulley. If the long body of the hook were against the pulley, especially a small lathe pulley, the belt would slide on the two surfaces of iron instead of turning the pulley around.

LATHE TOOLS

(Cutting tools to be used on work held between centers)

The Large Gouge (Fig. 143)

This is your roughing-out tool, and should be ground with as much nose, or curve, on the end as the hollow

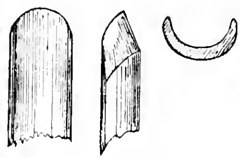


FIG. 143

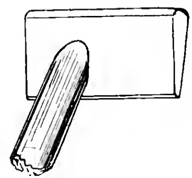


FIG. 144

of the tool is deep. It is sharpened with a stone, shaped for the purpose, and called a slip-stone. Both tool and stone are held up free in the air. Rub the stone on the

grind until a feather edge is felt down in the hollow, which is then removed by rubbing with the round edge of the slip (Fig. 144).

The large gouge is held so that it cuts high up on the

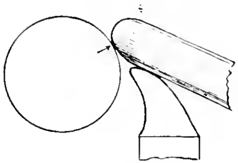


Fig. 145

wood, and tangent to the wood (Fig. 145), with the handle of the chisel held firmly in your right hand, against your hip.

Directions for Holding Large Gouge

On rest first, with handle down, and against your hip, and the grind of the tool rubbing, but not cutting the wood. Lift handle gently with right hand, until cutting edge cuts, moving the gouge to the right and left, the whole length of the wood.

Beginners often hold the chisel in a horizontal position, as shown in Fig. 146, and then wonder why the cutting edge is knocked off so quickly.

Lower your handle.

The tool may be held so that it cuts at its outer point, but if rolled over slightly, toward either side, it makes a more shearing, and therefore smoother cut (Fig 147).

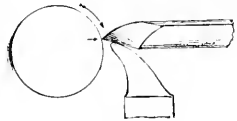


Fig. 146

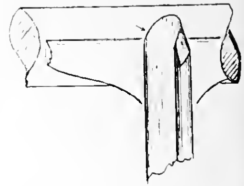


Fig. 147

Large Skew (Fig. 148)

This tool, which is the "smooth-plane" in wood-turning, is ground on both sides to enable you to turn in either direction—toward the right or left—the cutting edge being askew, or at an angle with the sides of the chisel.

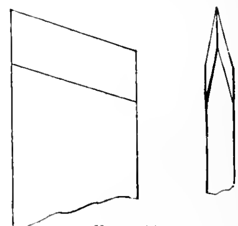


Fig. 148

By holding the skew in the proper manner, about 60° with the wood, and the chisel also being ground askew, instead of square across, the surface of the wood is cut

and smoothed off in the direction of and with the grain, instead of scraped across the grain and roughened.

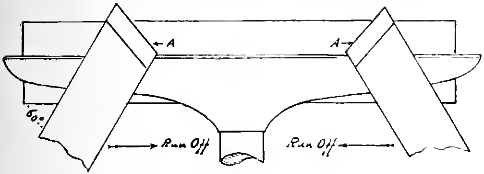


FIG. 149

Cut at a point near the obtuse angle A, A (Figs. 149, 150), the long acute angle being held high up in the air, away from the wood. Begin to cut 2 ins. or 3 ins. from either end of your wood, pushing your chisel clear off the

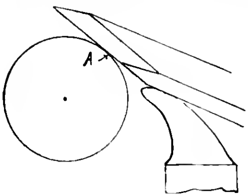


FIG. 150

other end. Never start at the extreme end, as the force of the lathe will draw your chisel into the end of the revolving wood, and either split the piece, or throw the chisel out of your hands.

Directions for Using Large Skew

Feet far apart.

Chisel on rest first—lift with right hand until grind rests on wood without cutting.

Lift gently, until cutting edge begins to cut, moving your whole body to right or left, without stepping or moving your feet.

Small Skew (Fig. 151)

This is your fine cutting tool, to make V grooves (Fig. 152) and beads (Fig. 153), and cut down square shoul-

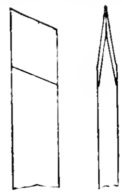


FIG. 151

ders, and should be ground on both sides, with as long a bevel as the temper of the tool will allow—a ½-in. bevel

FIG. 152

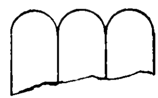


FIG. 153

is not too long—then sharpened without a second bevel, by holding the grind flat on the oil-stone. This tool is a very hard tool to hold rightly, so that it will not "run"—jump off your line to the right or left—and its proper use will require much patient practice and thought.

Turning work is seldom sandpapered—these exercises never—because the tool, if held rightly, will smooth and polish up the work as it cuts, much better than sandpaper, and without rounding over corners. The tool may be held in a wrong way, with its cutting edge up free and high, and not resting on the grind—making the work rough and full of "rings"—and it may be held rightly, with the grind held firmly against the wood to polish—the cutting edge barely touching—then by lifting the handle of the tool gently, the cutting edge is made to cut, the grind polishing immediately after.

The obtuse angle (Fig. 154) of the small skew must

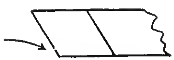


Fig. 154

always be used in cutting V grooves and beads, as the long point of any tool could not be guided truly down a slant or around a quarter circle without making rings in the work, as there is no supporting grind immediately next to your point to steady it. The obtuse angle has this supporting steel or grind on both sides.

The reason the obtuse angle cuts smoother than the acute is illustrated very simply in Fig. 155, which shows

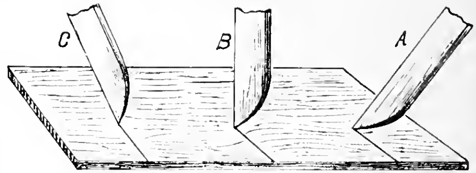


Fig. 155

why the front of the tooth of a cross-cut saw is given a bevel or pitch. A board is shown, across which we wish to make a deep mark with a knife; holding the knife as at A, it will push harder and tear the wood more than if held nearly perpendicular as at B. But if held as at C, it begins to cut gently up the blade from the point, preparing the wood for the sharp cutting point, making a shearing or slanting cut very smooth and fine. It follows that the cutting edge of a cross-cut saw tooth

Fig. 156

Fig. 157

should incline forward as at D (Fig. 156), rather than stand perpendicular as at E (Fig. 157), or hooked, as at F (Fig. 158).

FIG. 158

The small skew, held as at G (Fig. 159), with the obtuse point cutting, will cut more easily and do smoother work than if held as at H (Fig. 160), with the acute angle cutting.

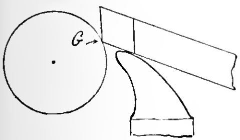


FIG. 159

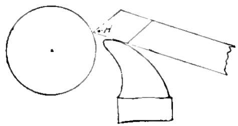


FIG. 160

In cutting V grooves, the tool is, of course, rolled over to the right or left, as you cut either side of the groove (Fig. 161), but there is danger in laying over the tool, as the slanting chisel is quickly drawn into the revolving wood, making it "run" or jump off your line in the direction in which it slants. A point will not "run," so by using the extreme point only, of the obtuse angle, holding your tool high up on the wood, raising your rest to help get the tool up, beginners may turn V grooves and beads without running.

Better results will be gained if instead of pushing the tool into the wood to make the V, the V is chopped out as you would chop with a hatchet, by making the lathe-rest the fulcrum of your lever, lifting the handle of your chisel straight up, throwing the obtuse angle of your chisel straight down into the V (Fig. 162).

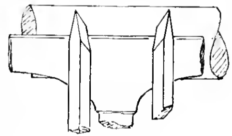


FIG. 161

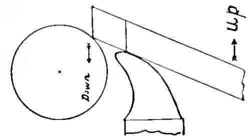


FIG. 162

To cut beads or convex curves, first knife between the curves with the long acute point of the tool, then with the tool laid flat on its side, and high up on the wood as at A (Fig. 163), start the cut with the obtuse angle of the

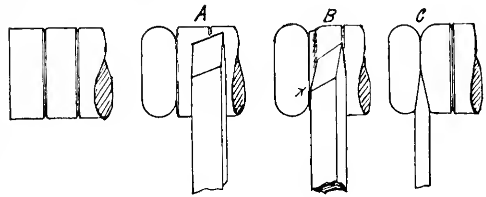


FIG. 163

tool, and as the cut proceeds, the tool must be gradually drawn toward you as at B, or the grind at x will scrape and spoil the bead already made. Finish the quarter

circle with the tool well forward, as at C. The tool must at all times be held at right angles to the wood, as shown.

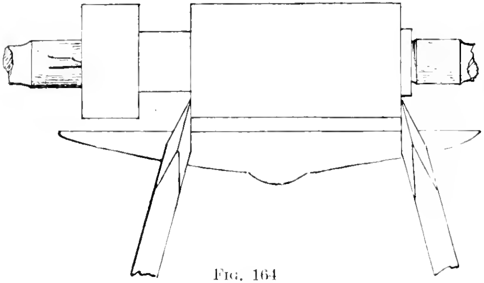


FIG. 164

To cut square shoulders, cut with the acute point, and swing the tool to the right or left, until the grind is at right angles to the wood (Fig. 164).

Small Gouge

This cutting tool should be ground somewhat differently from the large gouge, and sharpened so that the lips (Fig. 165)—two points on the curved end of the tool—will do all the work. The nose must be only as long as the chisel is deep, but the grind is continued farther up and around the sides (Fig. 166) than in the large gouge (Figs. 167, 168), to give the lips a thin, knife edge. Care must be taken to grind all the steel off, outside the cutting edge at A (Fig. 169), to leave the proper shape, like that at B (Fig. 170). The reason for this is very

FIG. 165

FIG. 166

FIG. 167

FIG. 168

plain. In making hollows, half circles, or concave curves, the chisel is rolled partly over to start the curve at the lips. The gouge, ground as at B (Fig. 171), will cut straight down for a $\frac{1}{32}$-in., making a true half circle, while the cutting edge or lip of a gouge, ground as at

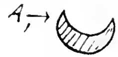


FIG. 169

FIG. 170

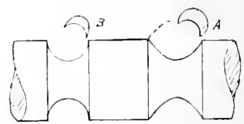


FIG. 171

A, will be pushed off immediately on entering the wood, making a curve like that shown at A, two of which make a poor half circle.

To make an opening, hold the gouge horizontally as at C (Fig. 172) and cut or scrape the groove, keeping well within your dimension lines; then roll your tool nearly over, as at D (Fig. 173), with the grind at right

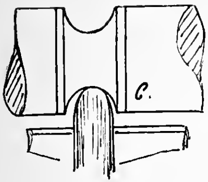


FIG. 172

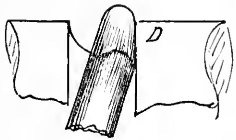


FIG. 173

angles to the wood. Push the gouge forward, rolling it over at the same time, and the grind will push the lips sidewise, out into the curve. Notice at E (Fig. 174),

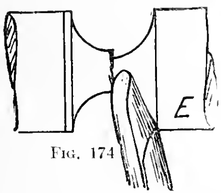


FIG. 174

how the beveled grind is lying against the finished curve, and as the gouge is pushed forward and rolled over, the cutting lip is forced down and out, making a quarter circle almost automatically—a very easy method for beginners.

Cut down to the center of the curve only, or on top of the grain—never try to run up against the grain on the other side of the curve. Cut down from the surface of the cylinder, swinging your chisel well over to the right or left, at each cut, to get the grind at right angles to the wood.

To Center Wood, and Clamp in Lathe

If the wood is square or rectangular, the crossing of the diagonals will locate your center (Fig. 175). If the

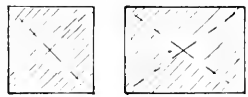


FIG. 175

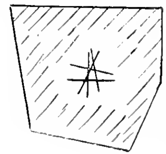


FIG. 176

piece is a split piece, of many sides, the center may be located by setting the points of the dividers a distance apart equal to the distance from any edge of the piece to the approximate center. Then with one point of the compass over the edge, draw the shape of the piece in miniature at the center (Fig. 176).

With an extra live center, provided by your instructor, drive the spurs deep into one end of the wood. Never drive the wood on the live center at your lathe—the lathe is too fine a machine for such rough usage. Oil the other end of your wood, setting the wood up on end, that the oil may penetrate deeply. See that the counter-shaft and the live spindle run easily by pulling on the connecting belt. Place the wood in the lathe, clamping the tail stock firmly, then screw up the dead spindle until the cup center is forced deeply into the oiled end

of your wood—so deeply that the live spindle will not turn. Do not move the shifting lever, but grasp the wood with both hands, and turn it back and forth in the lathe, until a deep ring is made in the wood by the cup center. Unscrew the dead spindle a half turn, and by pulling on the belt, try if the wood will turn with the cone pulley. Loosen the dead spindle another half turn, until the live spindle and wood revolve easily, then clamp the set screw or lever of the dead spindle carefully.

Do not move the shifting lever, but set your rest before starting. Move up and clamp your rest, so that it is parallel with the lathe centers, and about $\frac{1}{8}$ in. or $\frac{1}{4}$ in. above the center of your wood, also about $\frac{1}{8}$ in. back from the highest corner of your wood. Do not move the shifting lever, but try your lathe again, by grasping and pulling the belt, to see that the wood revolves easily and does not strike the rest at any corner. Never start your lathe before clamping your rest in position, and never move your rest while the lathe is running—it is a dangerous and foolish thing to do. Remember, a piece of wood, insecurely fastened in your lathe, and revolving at 3,000 revolutions per minute, is a dangerous thing to play with.

Now start your lathe—standing back out of danger—by moving over the shifting lever—*slowly, slowly.*

To Rough Out and Caliper

With the large gouge grasped in your right hand, and held firmly on the rest with the left—rolled over slightly to make a shearing cut—push gently into the wood, moving from end to end, back and forth, until the corners are cut off. Stop your lathe at first to see if the wood is round; later on you can safely lay your hand on the revolving wood, and feel for any high places.

Move up the rest $\frac{1}{8}$ in. away from cylinder as soon as corners are cut off.

It is better practice, for beginners, to stop the lathe to caliper the diameter. Do not force the calipers over the round edges, as the legs merely spring apart. Later on caliper the revolving piece, holding the calipers lightly against the wood, or the forward leg will be carried over the edge by the friction. Set your outside calipers to a dimension greater than the drawing calls for and make a cylinder of the same diameter from end to end. Set your calipers $\frac{1}{8}$ in. less and try again. Show it to your instructor. Stop your lathe and move up your rest.

With your large skew in the right hand and held firmly on the rest with the left, the long acute point of the chisel well up in the air, out of danger, feet far apart, polish with the grind, lift the handle of your tool until the cutting edge bears on the wood, smooth your cylinder, remembering to start 2 ins. or 3 ins. from either end with the large skew. Caliper this smooth cylinder, that it may be the same diameter from end to end. Show it to your instructor.

Set the calipers $\frac{1}{16}$ in. less and try again, and show it to your instructor.

Now set the calipers to the exact dimension called for on the drawing, and show to your instructor a cylinder,

perfectly smooth and polished, free from any bumps or rings, and of the required diameter from end to end.

Cutting Off

With your rule and a very sharp lead pencil, mark off the required length of your cylinder (Fig. 177), leaving

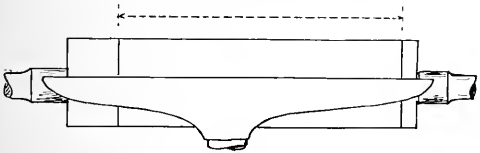


FIG. 177

much more wood at your live center than at your dead center, because your live center spurs are revolving, and will dull your tools if struck, while the dead center is still—dead.

With your $\frac{1}{4}$-in. scraping tool, held horizontally, and the flat side up (Fig. 178), push in gently, well outside the dimension line, making the square groove wider than the chisel, to prevent the heating of the tool by friction. A sufficient diameter must be left at the bottom of the groove to keep the wood solid and stable, while cutting down the square shoulders. With the small skew held horizontally, and swung to either side so that the grind is at right angles to the wood, push in with the long acute point of the tool, slightly deeper than the square groove (Fig. 179). Swing your tool still farther to either side, to cut out wide V grooves, to make room

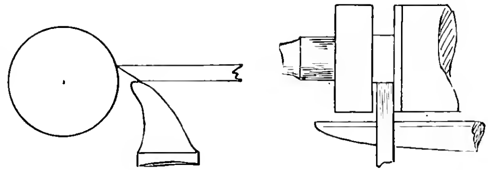


FIG. 178

for your chisel, that the point may not be burned, at the same time cutting off $\frac{1}{32}$ in. thick shavings from the square shoulders, until you are back to your dimension

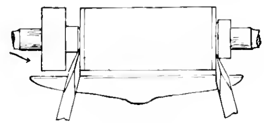


FIG. 179

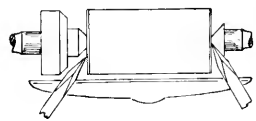


FIG. 180

lines, widening your V out each time, until the diameter at the tail end is only $\frac{3}{32}$ in. or $\frac{1}{16}$ in. and at the live end $\frac{1}{8}$ in. (Fig. 180). (Why larger at the live end?)

With the fingers of your left hand spread out and around the cylinder, to catch it grasp the skew in your right hand and push in at the live end of your wood, cutting the cylinder entirely free at that end, and it will stop in your hand (Fig. 181). There still remains the little dead end on your cylinder, which can be cut around and broken off with your skew held in your hand. Ends of cylinders are cut off either square or slightly hollow or concave. If concave at all, your instructor will not accept an end showing a hollow deeper than $\frac{1}{64}$ in.

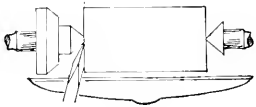


Fig. 181

Cutting off, without breaking out the end, is difficult work. After cutting off, show to your instructor, and ask his permission to cut another inch off your cylinder, then another, and another. The cylinder need not be centered with the live center punch each time. Screw it in your lathe and true it off, making it smaller each time it is cut off.

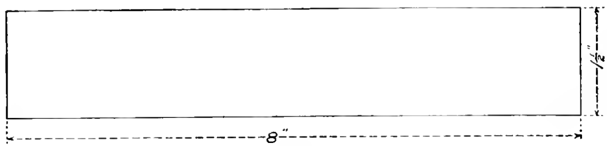


Fig. 182

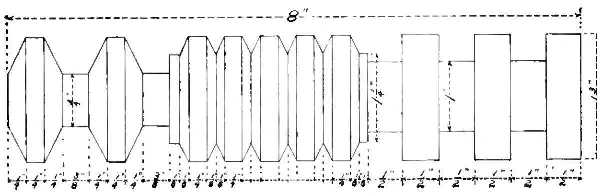


Fig. 183

These simple elements—square and V grooves, concave and convex curves—should be cut without the aid of a templet or form, the shapes being gauged by the eye alone. (Figs. 182, 183, 184.)

Where great accuracy of outline is required, the shape of the curve is transferred from the drawing to a thin

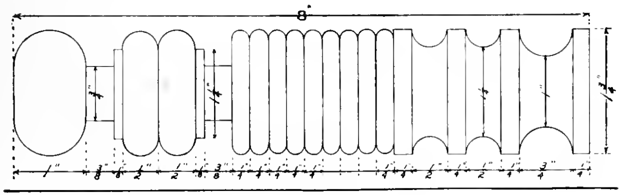


Fig. 184

sheet of metal or piece of wood, which is carefully cut or filed out, and used as a guide to secure the exact shape.

Beautiful combinations of these elements, which in some form enter into practically every piece of turned work, can be made. (See Figs. 200–202.)

Scraping Tools

Scraping tools, ground on one side only, and with a shorter bevel than the cutting tools, are used to scrape out grooves and beads and hollows, when the wood is held in the lathe in such a position that the tool scrapes, at times, with the grain. Notice that the cutting tools—the skews and gouges—are used on wood held between centers, at the ends, and with the exception of the large skew, cut directly across the grain. In turning rosettes, and patterns for pulleys, glued up of many segments (Fig. 185), the long cutting edges of the cutting tools would follow the grain of the wood and "run." Scraping tools

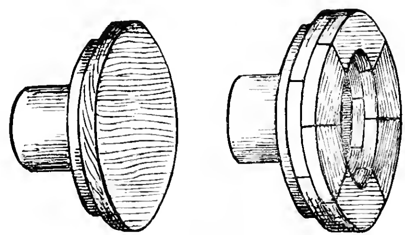


Fig. 185

(Fig. 186), of such shapes as are needed to make the required curves and squares, and ground only on one

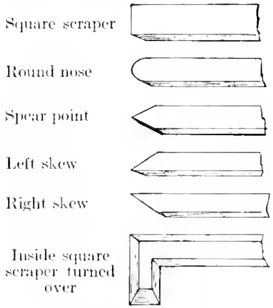


Fig. 186

side, are necessary for this work, because they will not "run" by following the grain.

Your tool drawer contains four face plates, which are numbered, and must be fitted only to that lathe which has a corresponding number.

It is much safer to saw off the corners of your wood at the band saw, after marking out the circle with the dividers, than to turn them off in your lathe, for fear both of splitting your wood, and of hurting your classmates with the flying pieces. Screw the face plate on the live spindle, and if the wood is soft pine or white wood, screw it on the center screw immediately by pushing hard and turning the wood slowly. If the wood is hard a small, shallow hole must be bored to start the screw.

Push the tail stock out of the way, set and clamp your rest at the center of your wood (Fig. 187), and $\frac{1}{8}$ in. away from and parallel to it, if the face of the block is to be trued off.

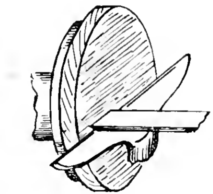


Fig. 187

Or clamp your rest outside the circumference, if the edge is to be smoothed off (Fig. 188), or at an angle with the wood (Fig. 189), and scrape with one side of the spear point.

Before starting your lathe, grasp your cone pulley and push sidewise, and if there is any movement, screw up with your hand the set screw at the left end of your lathe, until the side movement ceases, then clamp the set screw with the set nut.

Try the lathe by pulling on the belt, to see that it runs easily.

If the diameter of the wood is between 4 ins. and 6 ins.,

use the second speed until the work is trued off; then finish with the fastest speed. For larger diameters use second

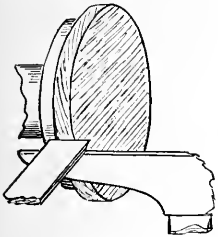


FIG. 188

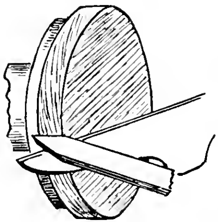


FIG. 189

or third speed. If the chisel is allowed to "dig," or if it is forced to take off heavy shavings, the wood will be "screwed up" on the center screw of your face plate, until a hole is bored by the screw, allowing the wood to fall from the lathe. For diameters above 4 ins., the wood will have to be fastened more securely to the face plate

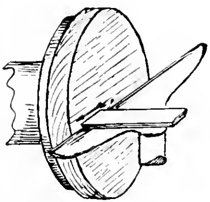


FIG. 190

by screws through the holes bored for the purpose. Scraping tools are to be held horizontally, always—scraping only from the center of the piece forward to the edge. What would happen if the tool were pushed against the wood back of the center?

To true off surfaces scrape with the wide square chisel, which must be ground and sharpened perfectly square across, at all times (Fig. 190).

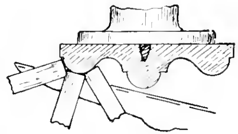


FIG. 191

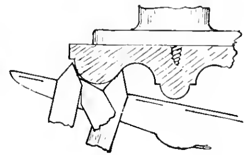


FIG. 192

To scrape beads, use the square or spear point tool, moving sidewise to the right and left (Figs. 191, 192).

In making hollows, it is better practice, and smoother work is made, if the round nose is pushed nearly to the bottom of the groove first, and then drawn back to smooth the sides, working from the bottom of the groove out (Fig. 193).

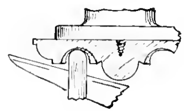


FIG. 193

Chucking

A chuck may be defined as a contrivance, usually made of wood, fixed to the live spindle or the face plate of your turning lathe, for holding the material to be turned. Many pieces, such as patterns for pulleys, round or octagon rings, spheres, have to be turned on

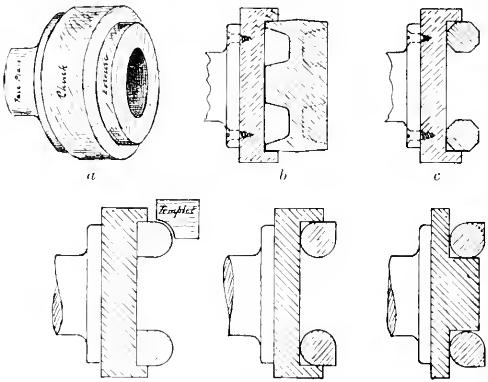


FIG. 194

both faces or on all edges, or both faces and edges. Having turned one face of a pulley or ring, it is impossible to turn it over and screw it to the face plate without marring or spoiling the finished face. So an extra piece of wood, preferably soft pine or poplar, is screwed to your face plate with screws, to form a chuck. A hole is turned in this wood, the exact diameter of the finished face or edge, and with care the half-turned pulley or ring or sphere is pushed in, tried until it runs perfectly true, and then turned as securely as if fastened to the face plate with several screws. The hole in the chuck must not be made too deep, as the piece must have a back to lie against to run true.

Figure 194, *a* shows a chuck screwed to the face plate, and holding a square ring, which is ready to be trued on the last face.

Figure 194, *b* gives a sectional view of a chuck, hold-

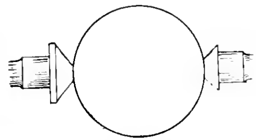


FIG. 195

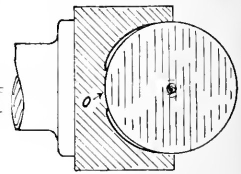


FIG. 196

ing the finished face of a small pulley, the other face being ready to turn.

Figure 194, *c* gives a sectional view of a completed octagonal ring held in its chuck.

In turning a round ring, two chucks will have to be used.

The drawing also shows the templet, or shape, which can be used as a guide in making the perfect curve.

A sphere is a beautiful exercise to turn in a chuck. First turn it as round as is possible between centers, and cut it off (Fig. 195). Make a chuck, half the

diameter of the sphere in depth, and shaped out inside, so that the chuck will bind hard at the outer edge only, but having a back stop O, that the sphere may not be pushed too far in (Fig. 196). Keep in mind that turning between centers made the piece round across the grain, so your first work is to get it round lengthwise.

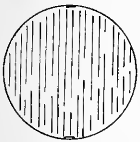


Fig. 197

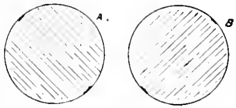


Fig. 198

Push the piece into the chuck with the bad ends of the sphere on a horizontal line parallel to the face plate—or more simply, with one of the bad ends toward you, that the piece will turn over endwise. Do not try to get it perfectly round lengthwise at first, but keep revolving the sphere in the chuck (Fig. 197), that the piece may be scraped with the grain, then at 45° with the grain, both ways, as at A and B (Fig. 198). One chuck is sufficient for the sphere, as the hole may be made smaller by merely scraping off the face of the chuck.

If the material for the sphere is precious, such as ivory, or if you have a square block of wood, but slightly larger than the sphere wanted, it is of course impossible to turn it first, between the dead and live centers. Chuck it immediately, by cutting a square hole in the chuck to receive the material (Fig. 199).

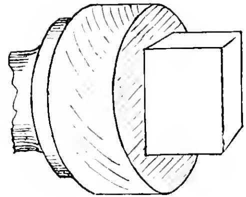


Fig. 199

The exercises on page 94 (Figs. 200–202) are to be filled and waxed in the lathe, before cutting off centers.

Centers are to be sawed off with back saw, while the exercise is held in the bench hook. The ends are then cut rounding and smooth with sharp chisel, sandpapered, filled, and waxed.

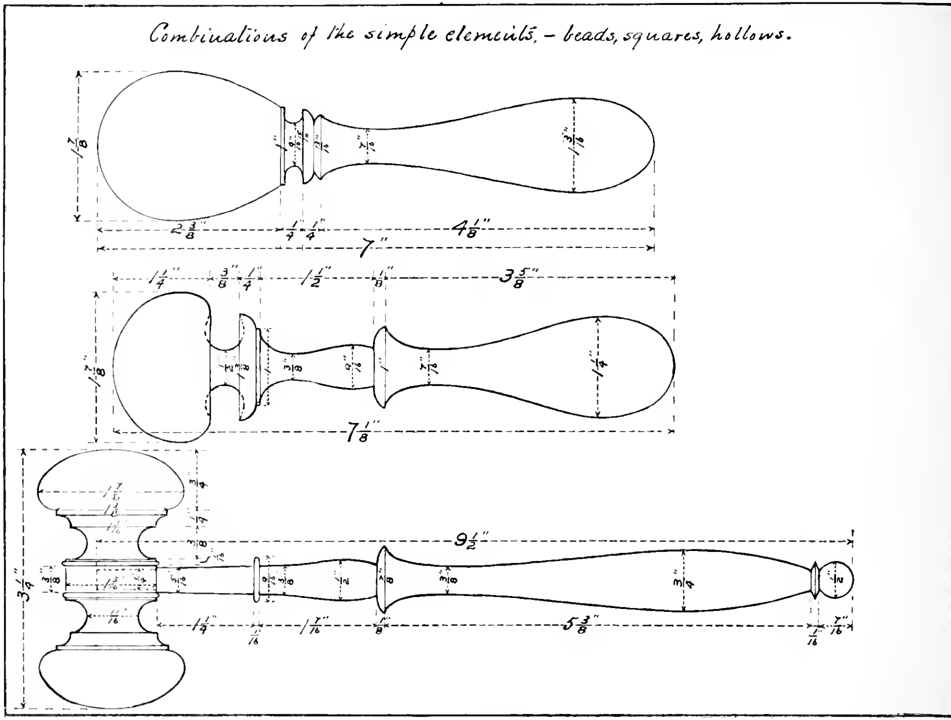
Face Plate Turning. Pin Tray

Select a piece of bird's-eye or curly hard maple, or knotty piece of curly cherry or sycamore.

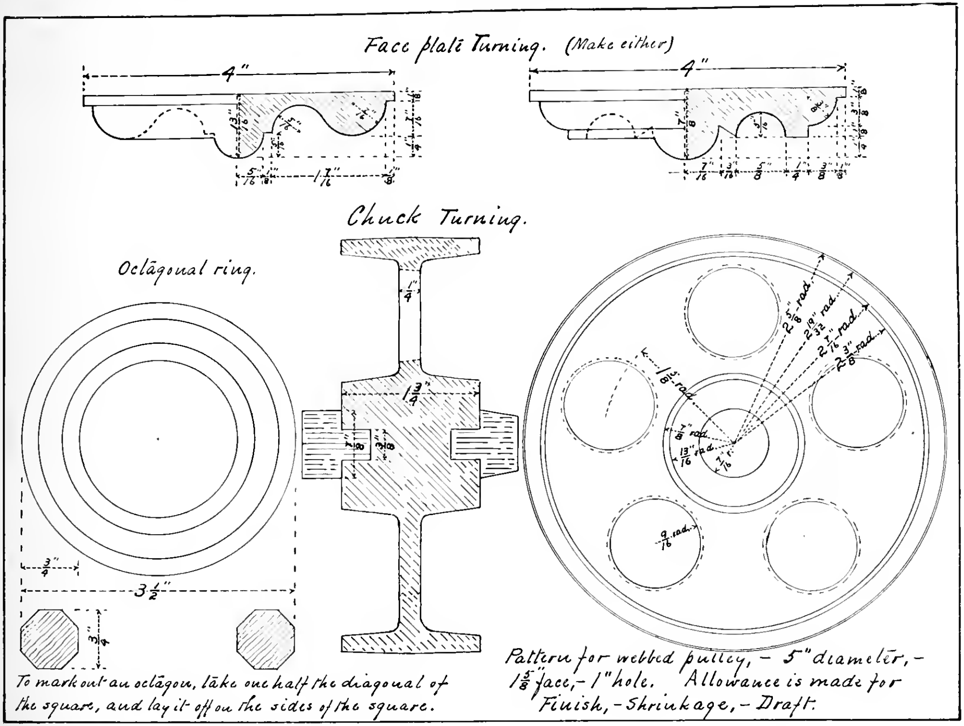
Saw $\frac{1}{8}$ in. larger than required diameter, glue on poplar or pine piece, sawed to about diameter of face plate, fasten to face plate with short screws (Fig. 204–*a*).

Turn, using highest speed of lathe, with scraping tools only. Sharpen scraping tools carefully before taking off last shavings, or the tools will tear the thin edges of wood.

Reduce speed of lathe and sandpaper, first with No. 1, finishing with No. 0 sandpaper. Sandpaper will burn the wood if lathe is run at highest speed.


Combinations of the simple elements, – beads, squares, hollows.
7"
$7\frac{1}{8}$"
$9\frac{1}{2}$"
$2\frac{3}{8}$"
$4\frac{1}{8}$"
$3\frac{5}{8}$"
$5\frac{3}{8}$"
$3\frac{1}{4}$"

FIGS. 200-202



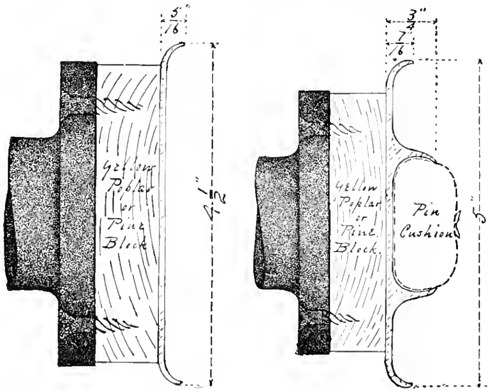
Face plate Turning. (Make either)
Chuck Turning.
Octagonal ring.
To mark out an octagon, take one half the diagonal of the square, and lay it off on the sides of the square.
Pattern for webbed pulley, - 5" diameter, - 1 5/8" face, - 1" hole. Allowance is made for Finish, - Shrinkage, - Draft.

FIG. 203

Finishing

Stop lathe and fill the trays with wood filler, letting it dry 15 or 20 minutes.

Start the lathe at slowest speed, rubbing the filler into the wood, instead of merely rubbing it off. Let dry 24 hours and repeat, polishing after each coat with soft cloth.



a Pin Tray

b Pin Tray and Cushion

Fig. 204

Stop lathe, and wax, rubbing wax over and over trays, and let dry 15 or 20 minutes.

Start lathe at slowest speed and polish wax with soft cloth, and let dry 24 hours. Repeat coat of wax and let dry 24 hours.

Unscrew face plate from block, screw block into bench vise and saw off tray, cutting the tray from the block in case the lathe heats the tray, causing it to warp.

Carefully scrape wood and glue from bottom of tray with sharp chisel, fill one coat, and wax.

The pin cushion may be bought in any dry goods store, the diameter of the center part of the tray being $\frac{1}{8}$ in. less than the diameter of the cushion.

To hold the cushion in place, undercut the sides of the opening to receive it—make the hole larger in diameter at the bottom than at the top (Fig. 204, *b*).

HAND MIRROR

(Combination Turning and Cabinet Exercise, Fig. 205)

Stock Bill

1 P—8"x6"x$\frac{1}{2}$" or $\frac{7}{16}$"—frame and handle.
1 P—5$\frac{3}{8}$"x5$\frac{3}{8}$"x$\frac{1}{8}$"—glass back.

Screw to face plate a block of yellow poplar 6 ins. square and $\frac{7}{8}$ in. or $\frac{3}{4}$ in. thick, and turn off face true.

Screw to this block the piece for frame and handle, as shown, placing screws outside of round frame (Fig. 206).

With dividers set to 5 ins., the distance from center of live spindle to bed of lathe, describe arc on lower end of frame piece, and saw at band saw. Turn out rabbet for glass, with radius of $2\frac{9}{32}$ ins., making rabbet $\frac{3}{16}$ in.

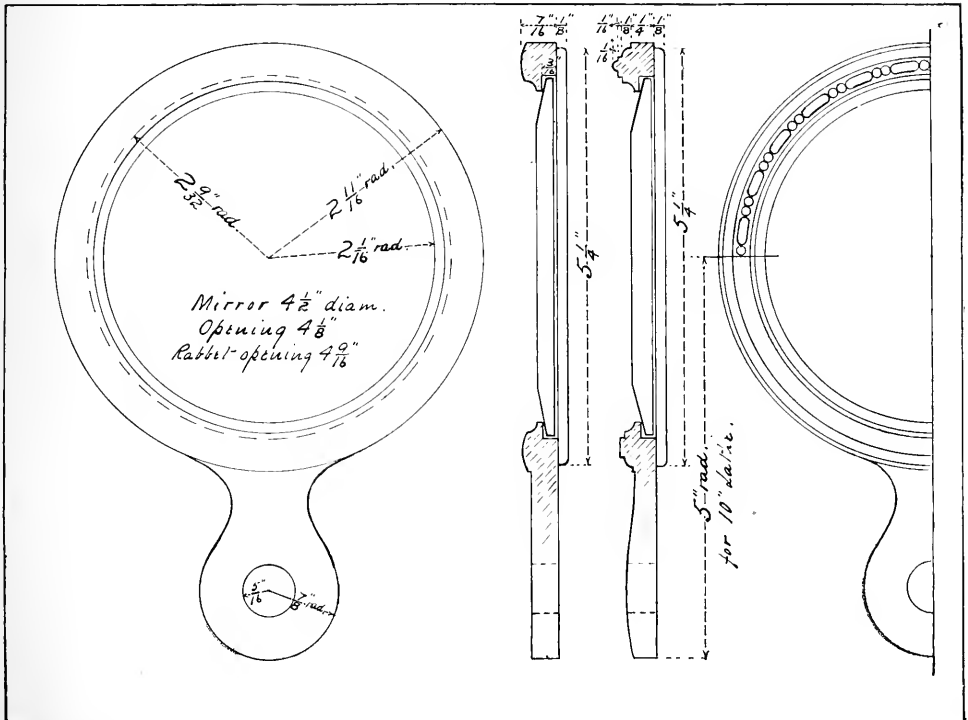

$2\frac{9}{32}$" rad.
$2\frac{11}{16}$" rad.
$2\frac{1}{16}$" rad.
Mirror $4\frac{1}{2}$" diam.
Opening $4\frac{1}{8}$"
Rabbet-opening $4\frac{9}{16}$"
$\frac{5}{16}$"
$\frac{7}{8}$" rad.
$\frac{7}{16}$" $\frac{1}{8}$"
$\frac{3}{16}$"
$5\frac{1}{4}$"
$\frac{1}{16}$" $\frac{1}{8}$" $\frac{1}{4}$" $\frac{1}{8}$"
$\frac{1}{16}$"
$5\frac{1}{4}$"
5" rad. for 10" lathe.

Fig. 205

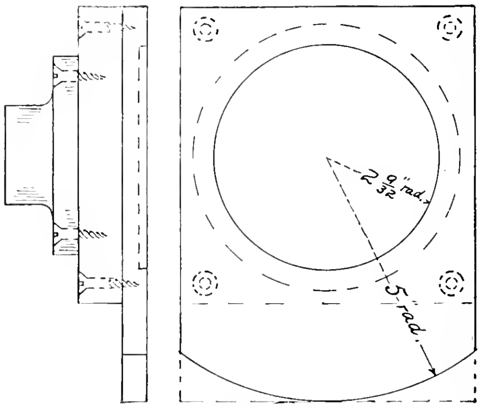


FIG. 206

deep, turning out the whole diameter $4\frac{9}{16}$ ins. to $\frac{3}{16}$ in. deep. Unscrew frame from block and saw block round, at band saw, making it about $5\frac{3}{8}$ ins., the diameter of outside of frame.

Turn, on the block, a raised place $\frac{3}{16}$ in. high, and exactly $4\frac{9}{16}$ ins. diameter, making it a chuck, on which fit the frame just turned (Fig. 207).

Turn the frame, making any style desired, plain or ornamental—the plain is more serviceable.

Care must be taken not to cut down too far on outside of frame, or handle will be too thin; the outside of frame and handle must be sawed at band saw.

Run the lathe slowly and cut out center piece last, as it helps hold the $\frac{5}{8}$ in. wide frame on chuck securely. Push in with diamond point held at an angle to cut straight in, and center piece will fall away (Fig. 208).

Sandpaper frame lightly with fine sandpaper.

Round over face of handle with spoke-shave and file, to match arc of circle on face of frame, and sandpaper carefully.

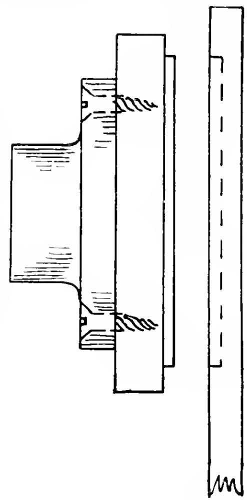


FIG. 207

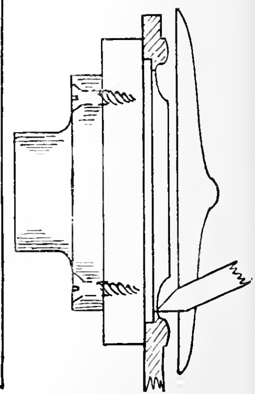


FIG. 208

Saw out glass back—it is easier to saw it than turn it. Round over edge slightly, and plane inside face for glue joint.

Fill and wax following directions under FINISHING, taking care that no wax or filler get on back of frame or inside of glass back, as glue will not hold.

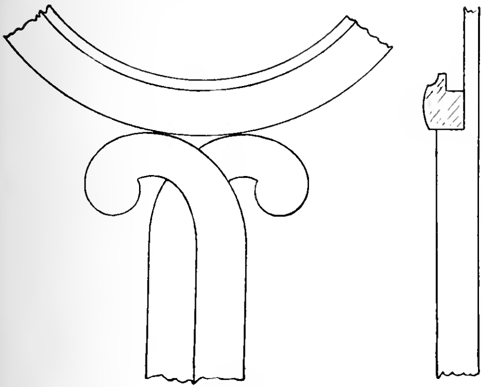


FIG. 209

Fasten mirror in place with many little triangular glue blocks, let dry 2 hours, and glue down glass back with hand screws.

Cut off glue, sandpaper, fill and wax corner.

If a longer handle to frame is desired, turn the frame round, in separate piece.

Make glass back and handle in one piece, sawing away the thickness at glass back to receive the frame, as shown (Fig. 209), fitting the round frame to the handle, at the scrolls.

TURNED INKSTAND AND PENHOLDER

Construction (Fig. 210)

Plane one face of base true, saw round at band saw, and screw true face to face plate, using short screws that will not come through base.

Turn the molding on edge of base, true and smooth outside face, then sandpaper with No. $\frac{1}{2}$ sandpaper, while lathe is running slowly, or sandpaper will burn wood.

Filling and Waxing

Unscrew face plate from lathe, use white filler, and fill base, letting filler dry 10 minutes or longer. Return face plate to lathe, run lathe slowest speed, and rub filler in wood with cloth. Polish filler with clean cloth, and let dry 24 hours. Repeat process and let dry 24 hours. If wood is open grained, give three coats of filler.

Waxing

Unscrew face plate from lathe and wax the base, letting wax dry ten minutes. Return to lathe, run slowest speed and polish, then let dry 24 hours. Repeat, and let dry 24 hours, giving two or more coats as wood requires.

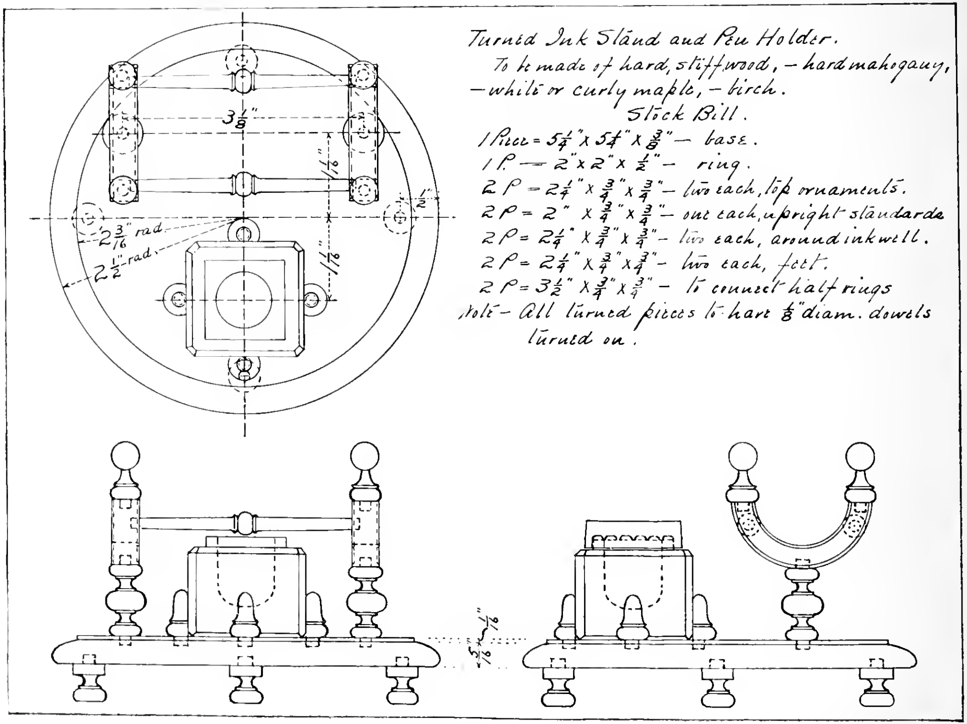

Turned Ink Stand and Pen Holder.
To be made of hard, stiff wood, — hard mahogany, — white or curly maple, — birch.
Stock Bill.
1 Piece = 5¼" x 5¼" x ⅜" — base.
1 P. — 2" x 2" x ½" — ring.
2 P = 2¼" x ¾" x ¾" — two each, top ornaments.
2 P = 2" x ¾" x ¾" — one each, upright standards
2 P = 2¼" x ¾" x ¾" — two each, around inkwell.
2 P = 2¼" x ¾" x ¾" — two each, feet.
2 P = 3½" x ¾" x ¾" — to connect half rings
Note — All turned pieces to have ⅛" diam. dowels turned on.
3⅛"
1 1/16"
1 1/16"
½"
2 3/16" rad.
2½" rad.
5/16"
1/16"

Fig. 210

To Turn Ring

Saw piece round at band saw, bore hole in center to receive center screw of face plate, and screw to face plate slowly, to prevent splitting.

Turn ring to diameter, also inside diameter, also $\frac{1}{32}$ in.

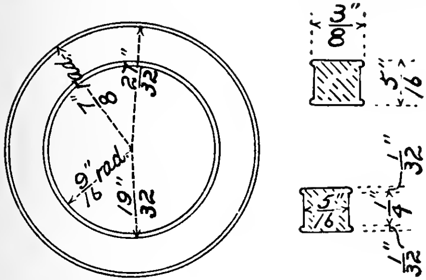


Fig. 211

beads on face, as shown on drawing (Fig. 211). Sandpaper outside surface, inside of hole, and beads, carefully, while lathe runs slowest speed.

Knock out center screw on face plate, and screw on block of yellow poplar with three screws, making of yellow poplar a chuck, to hold finished face of ring. Make hole in chuck only $\frac{1}{8}$ in. deep, push in ring, and turn to required thickness, $\frac{3}{8}$ in., turning the $\frac{1}{32}$ in. beads on this face also. Sandpaper with lathe running slowly.

Fill with white filler, two coats, letting each coat dry 24 hours.

Wax the ring, giving two or more coats, as wood requires, letting wax dry 24 hours between each coat.

Turn two top ornaments in one piece of wood (Fig. 212).

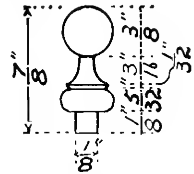


Fig. 212

Sandpaper carefully, or sandpaper will spoil little sharp elements.

Fill and wax.

Cut off ornaments carefully, especially at top round end, bore $\frac{1}{8}$ in. hole in chuck for dowel of ornament, push it in, and sandpaper top end round.

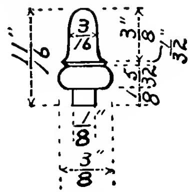


Fig. 213

Same process may be followed with posts around inkwell (Fig. 213).

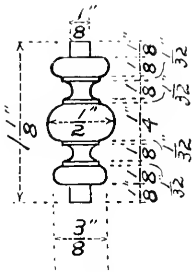


FIG. 211

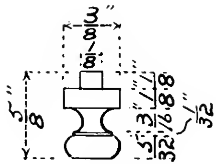


FIG. 215

Turn only one upright standard at a time (Fig. 214).

Turn two feet in one piece of wood (Fig. 215).

If the 3 ins. long connecting rods for half rings vibrate

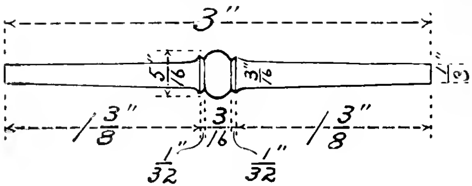


FIG. 216

too much, make instead $\frac{3}{16}$ in. diameter straight rods, which may be planed at the bench, in the bench hook (Fig 216).

Assembling Parts

Saw ring into two equal parts, sawing with the grain.

Plane top ends of each half ring, one end at a time, in bench hook, screw in vise, and bore $\frac{1}{8}$ in. diameter holes with drill bit, which will not split wood if hole is bored slowly. Mark off centers for connecting rods in sides of half rings, $\frac{5}{16}$ in. down from ends. Bore slowly, holding half ring in hand.

Do not glue until everything is fitted dry.

Find center of under side of half circles, and bore for upright standards.

Lay out on base two center lines at right angles to each other, marking with fine lead pencil.

Draw line parallel to the line running with the grain, $1\frac{1}{16}$ ins. back from it. The centers of holes for upright standards are on this line, $3\frac{1}{8}$ ins. apart.

Continue center lines to under side of base, and lay out centers of holes for feet, $\frac{1}{2}$ in. in from outside edge of base.

Fit connecting rods of half circles dry, without glue.

Glue upright standards into half circles, also top ornaments.

Glue upright standards into base, and connecting rods into half rings, at one time, taking great care that upright standards stand vertically, and not in wind, and that connecting rods are straight and true.

Glue in feet, and let dry 2 hours.

Glass Inkwell

The simpler square, cut glass inkwell is in better taste.

No dimensions can be given for these inkwells, as

each one is untrue in itself—$1\frac{1}{2}$ ins. square is about the size.

Hold inkwell on base in position shown on drawing, and mark a short line along each side. Bore with $\frac{1}{8}$ in. drill bit, so that diameter of bit just touches line on outside (see drawing).

Plane off one side of little posts down to the dowel—do not plane the dowel—and fit posts to base dry, without glue, with inkwell in place.

Glue in posts, with inkwell in place, holding posts with fingers until glue is set. Let dry 2 hours.

Remove inkwell, and re-wax and polish with clean cloth.

Base may be made rectangular in shape, 6 ins. x 4 ins., using same turned penholder and same turned feet, with a distance of $4\frac{1}{2}$ ins. between centers of upright standards, giving space for two inkwells, or base may be made elliptical in shape—6 ins. x 4 ins.

SUGGESTIONS FOR YOUR CONDUCT IN THE TURNING SHOP

Your place is at your own lathe, always.

Be careful not to interfere with other men, when leaving your lathe to show your work to your instructor.

Should your work be interfered with by the stopping of the motor, or the absence of your instructor, or for any other reason, stand at your lathe; remember your place is at your lathe.

Permission must be asked, at all times, to leave the shop.

Quiet talking is permitted only as long as it does not interfere with your work.

Congregating at the grindstones or the band saw will not be permitted. If you must wait your turn, wait at your lathe, then move up not closer than six feet from the grindstone or band saw. Crowding a man at the machines, or distracting his attention, or interfering with him in any way is dangerous, and will not be allowed.

The wood given you is to practice on, not to throw away, so save all cylinders for practice. Your instructor's permission must be secured before taking another piece of wood.

Small cylinders or ends are not to be thrown on the floor, for fear of causing your class-mates to fall by stepping on them. Such pieces are to be thrown into a box, provided for the purpose.

The long stick, used to throw the belts on the cone of the countershaft, must be returned to its proper place by the person using it.

In throwing the heavier horizontal belts, be careful to grasp the over-head stringers or the countershaft, firmly, with one hand, while throwing the belt with the other, for fear of being pulled from the ladder.

SUGGESTIVE QUESTIONS

Turning

1. Make a sketch of a speed lathe and countershaft, and name each part.

2. How is the size of a lathe designated?
   Where is the measurement taken?
3. Why have a collar on each end of the countershaft?
4. Why have collars on shifting rod?
5. Why is the bed of the lathe planed true?
6. What is the head stock of a lathe?
7. Describe the live spindle fully and tell what is fastened to it.
8. Make a sketch of the live or spur center, and tell why it is so named.
9. Why are the boxes or bearings split, and how are they adjusted?
10. How is any lateral or side motion taken up?
11. What is the tail stock?
12. Describe the tail spindle.
13. Make sketches of two tail centers, and give reasons why you think the cup center is the better one.
14. How do you clamp the dead spindle, that it may not unscrew and allow the wood to fly from the lathe?
15. What is a lathe rest, and why is it necessary?

Countershaft

16. What is the use of the countershaft?
    Is it necessary? Why?
17. What is a tight pulley? A loose pulley?
18. What holds the countershaft and boxes in place?
19. Make sketches of two kinds of hangers.
20. Explain carefully how different speeds are obtained by means of the cone pulleys.
21. What is the shifting rod?
    What forks and collars are fastened to this rod? Explain their use.

Oiling Loose Pulleys

22. Why is it necessary to oil the loose pulley frequently?
    Make a sketch showing where the pulley may be oiled.
23. Make a sketch showing how the loose pulley is oiled by means of a grease cup screwed on to the end of the countershaft.
24. What is a compression grease cup?
25. Make a sketch showing another method of oiling a loose pulley, in which a "bushing" is used.
26. Make a sketch of a loose and tight pulley so arranged that the strain on the belt is reduced when on the loose pulley.
    Is this a good method? Why?
27. Make a sketch of a countershaft so arranged that the lathe may be stopped as usual, and still have no loose pulley.
    Is this a good method? Why?
28. How do loose pulleys cause so much trouble?
29. Make a sketch of a poor method of oiling a loose pulley, and explain why it does not work well.

Care of the Lathe

30. Give rules for care of the lathe.
31. Should parts of the lathe ever be pounded apart with a hammer or pried apart with a screw-driver? Why?
32. Is it necessary to take up the side or lateral motion of the live spindle as long as the wood is held between centers?
33. When only is it necessary to take up all lateral motion?

Speed of the Lathe

34. At what speeds will the lathe run, and what size diameters may safely be turned at each speed?
35. Why must hard wood be turned at a slower speed than soft?
36. What speeds must be used for rough, unbalanced stock?
    For patterns glued up of many pieces?

Belts

37. Of what are belts made? What is a short-lap belt, and how are the pieces fastened together?
38. Make a drawing showing how to lace a belt with wire or raw-hide belt lacing.
39. Explain why this lacing must never be crossed on the inside of the belt.
40. How do you fasten the ends of a raw-hide belt lacing?
41. What are belt hooks? Make a sketch showing a belt fastened together properly with belt hooks.
42. Which side of the hook is inside? Why?
43. What objection is made to the use of belt hooks?

LATHE TOOLS

Large Gouge

44. What is the large gouge used for?
    How should it be ground and sharpened?
45. Why should the gouge be held tangent to the wood?
    What happens to the cutting edge if held horizontally?
46. Explain why rolling the gouge over to get a shearing cut makes it cut smoother.

Large Skew

47. For what is the large skew used? Why is it ground askew? Why ground on both sides?
48. Make a sketch showing how it is to be held high upon the wood.
49. Is it safe to begin to cut with the large skew at either end of the revolving piece? Why?

Small Skew

50. For what work is the small skew used?
    How should it be ground and sharpened?
51. Explain how a turning chisel may cut and smooth and polish much better than sandpaper.
52. Why must the obtuse angle be used to make V's, and beads and bevels, rather than the acute angle of the tool?

Make a sketch of a knife blade in three positions, illustrating your argument.

53. Will a point "run"? Explain how a skew may be held so that it will not run, even if it is rolled over to either side.
54. Why "chop" with the skew, rather than push it into the wood?
55. Give the complete directions, with sketches, for cutting beads with the obtuse angle of the small skew.
56. To knife and cut down square shoulders, what point of the tool should be used?

Make a sketch showing how the grind or bevel of the tool must be at right angles with the wood to cut down a square shoulder.

Small Gouge

57. Explain carefully how a small gouge is ground and sharpened.
58. Make a sketch showing the shape of a section of the tool, after the grind has been carried up and around the sides to prepare the lips for sharpening.
59. Make a sketch showing how the gouge is rolled nearly over in starting to make a perfect half circle.
60. Explain why the gouge is pushed forward while the lip is cutting down the quarter circle.
61. Should the grind be at right angles with the wood? Why?

To Center Wood

62. How center rectangular or square wood?

How center a piece of many unequal sides?

63. Give full and careful directions for placing the wood in the lathe.
64. Why oil the wood at one end?
65. Should the rest be moved while the wood is revolving?
66. What tool is used to measure diameters of cylinders? Name two kinds.
67. In laying out cylinders in the lathe, why leave a larger space at the live center end?
68. How is the $\frac{1}{4}$ in. scraping tool held? Why use flat side up?
69. Explain carefully how to cut off a cylinder at both ends.
70. Why make a wide V at either end in cutting off?
71. What is a templet? Why are they used?

Scraping Tools

72. How are scraping tools ground? Why are scraping tools needed? Why scrape with the flat side up?
73. State carefully the difference in the cutting of the regular turning chisels and the scraping chisels.
74. Make a sketch showing the direction the grain runs in some pieces of face-plate work.
75. Make sketches of six scraping tools, and name each

76. Is it safe to turn off the square corners of a piece of wood screwed to your face plate?
Name a better way to get rid of the corners.
77. Make sketches showing two chisels that may be used to turn off edges of face plate work.
78. For large work, how is the wood fastened to the iron face plate?
79. To make beads, how do you hold the tools?
80. In making hollows, why is the tool pushed nearly into the required depth, first, then drawn out?

Chucking

81. What are chucks?
Why are they needed?
82. Make a sketch showing how a pulley is chucked to turn the last face.
83. Make a sketch showing the two chucks necessary to turn a round ring.
84. How is thin face-plate work held in the lathe to turn?
85. Is it good practice to run the lathe very fast while sandpapering? Why?
86. Describe carefully the "finishing" of wood work in the lathe.
87. Is it better practice to cut off such finished work in the lathe or at the bench? Why?

CABINET MAKING

Cabinet making differs from Carpentry in that the wood used is generally harder—such as oak, cherry, sycamore, maple, mahogany—to work which sharper tools are required, and since the hard woods have more curly grain than the soft, the cover of the plane-bit must be set so close as to leave but a hair line of cutting edge.

In rough carpentry work joints are often made with the saw alone, and joints are nailed together, and moldings nailed on, even in the interior hard-wood finishing of houses, while in cabinet making nails are seldom used, the joints being glued and clamped together.

Carpentry work, if finished (varnished), is varnished by having the varnish flowed on—that is, two or three coats are carefully brushed on very smoothly and left just from the brush—while cabinet work is usually given from three to five coats of rubbing varnish, then rubbed down with pumice stone and water or oil, to make a perfectly true surface, and then polished, or left dead or dull.

In cabinet work, as well as in the better carpentry work, several appliances are used to force the two or more pieces of wood together to make a good glued joint. These are hand screws—hand clamps—made of iron or wood, and large iron presses for veneering (which is gluing on a common board a thin, finely grained board or sheet of wood).

These hand screws require care to use properly (Fig. 217). The jaws must be kept parallel, or the two pieces being glued will be forced apart, rather than together, as shown. The shoulder screw A, and the shoulder jaw *a*, turn on each other easily and freely, there being

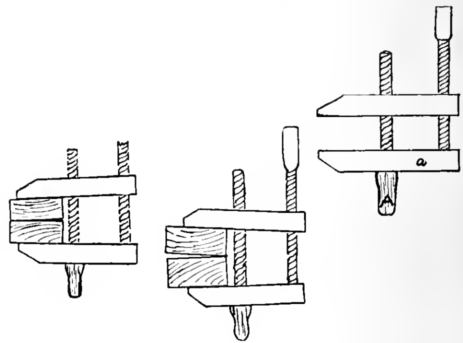


Fig. 217

no thread in the holes of this jaw. The other jaw and screw, the clamp jaw and clamp screw do all the moving up, to tighten, so to use the hand screw properly, grasp the shoulder screw in the left hand, the clamp screw in the right, screw up or unscrew naturally, turning the whole hand screw around with the right hand, until the jaws are open far enough, then set the jaws by turning the shoulder screw with the left hand, screwing up to tighten only with the clamp screw in the right hand. An old form of hand screw, often seen in the factories, in the possession of foreigners "just over," is shown in Figure 218. Very large hand screws are too clumsy to handle,

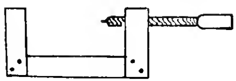


FIG. 218

so for wide work hand clamps, made of wood or iron, are used. The back edge of the blade is notched out, that the shoulder block may be set any distance away

FIG. 219

from the clamp screw (Fig. 219). When very heavy work is required, the blade or bar is made of heavy timber and mounted on legs, while the screw is turned by

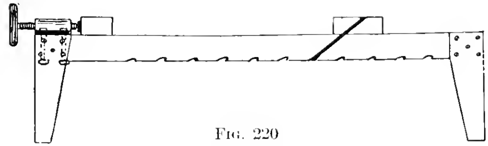


FIG. 220

a wheel of a large enough diameter to get a good leverage (Fig. 220).

Hand screws and hand clamps are sold by the length of jaw and the amount of opening, and cost from $2.00 a dozen, for small 6 in. jaws, to $20.00 a dozen.

A simple and cheap, as well as very satisfactory clamp to joint up such work as table tops, or taboret tops, is shown in Figure 221. It consists of a strip of some stiff wood and a block glued and screwed on each

FIG. 221

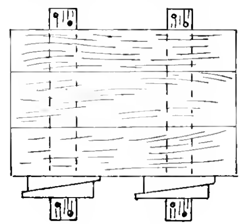


FIG. 222

end. Two wedges are also required. These simple clamps, which are much used and easily made, are shown in Figure 222.

The two or more boards to be glued must be jointed in one of two ways: the edges must be planed perfectly true and perfectly straight, or the edges may be jointed a little concave, only the thickness of one or two shavings concave, making the boards appear as shown in

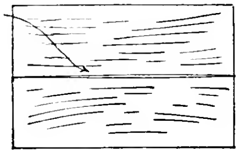


Fig. 223

Figure 223, when ready to be glued. The argument in favor of the latter method is this, that no matter how well seasoned, the wood will dry faster at the open ends of the fibers than in the center of the board. By gluing with good glue, and forcing the boards together in the open center, the fibers at the ends, being under pressure, are less likely to open, and leave a hair crack at the ends of the glue joint.

A well made glue joint, using glue only, to hold two pieces of wood together, is considered quite as strong as a joint made by using dowel pins or tongues to connect the two pieces. The object of the pressure, in making all glue joints, is to force the glue entirely from between the two surfaces, up into the open pores of the wood, so that the glue, instead of lying in a layer between the two pieces, forms itself instead into hundreds of little dowels, connecting and extending up into the two pieces. A good glue joint, carefully split open with a chisel, will show these fine points of glue.

In gluing ends of wood together, it is better to size the ends first—that is, fill the open ends of the fibers by rubbing into the jointed ends thin, hot glue, with the fingers. The object of sizing is to prevent the open pores of the wood taking all the water from the glue.

Rubbed glue joints may be made by first jointing the edges perfectly straight, then rubbing the two glued surfaces together, pressing hard, until all the glue and air are rubbed out, and the pieces "stick."

Glue, to work well and hold well, should be hot, and should be thin enough to flow easily. The wood also should be placed in a heating oven, until quite warm, that the glue may not be chilled when brushed on. Cold glue is poor stuff to work with; do not expect good results in using it, because when cold it does not flow up into the open pores and dry there, clutching the pieces together, but instead lies in a thick mass between the pieces, spoiling the joint and breaking open as soon as the boards receive a shock or sharp blow.

Glue should be soaked in cold water over night if in thick pieces. If in thin pieces it softens quite easily while the water is heating.

The glue pot should be a double pot, a kettle of water outside of a pot to hold the glue. Enough cold water should be poured over the glue to cover it (some kinds

of glue require much less), then this pot placed in the kettle of boiling water, the glue requiring to be stirred at intervals. To make glue at home, buy a half pound of some good, white glue for 10c. or 15c., place in a thick teacup, cover with water, then place the teacup in a tin cup full of water, and stir occasionally.

Glue is made from the refuse parts of animals—cartilage, strippings of hides—boiled down to a jelly. A quantity of zinc salts is stirred and mixed with it, to give it its white color—the more zinc stirred in, the whiter the glue. The lighter and white glues are necessary in cabinet work on account of the lighter colored woods now used; the old dark glues would show a black line in the joint in white maple. Capsules, to hold doses of quinine, are nothing but glue (gelatine). Glue nowadays is a clean, nice product, when compared with the vile, ill-smelling stuff formerly made.

Dowels

As stated above, nails are seldom used in cabinet work—glue is quite as strong to hold, and there is no marring of the surface with nail heads or nail holes. Where special strength is required in fastening together two or more pieces, holes are bored in each piece, and a short round pin or dowel is glued in the holes to stiffen the joint. The dowels really act as tenons, but as they can be bought to fit any size of bit used in the brace or boring machine, from ¼ in. to 1 in., they are much more convenient and much cheaper than tenons, if the tenons are hand made. In chair work, especially, dowels are nearly always used, as it is much easier to bore a hole in the curved pieces of the chair, than to cut a tenon and a corresponding mortise in the pieces.

Dowels are cut in a dowel machine, which has a cutter somewhat similar to a lead pencil sharpener, with the hole straight through, of course, instead of cone-shaped. They are sold at hardware stores, any size, in lengths of about 3 ft., and cost from 1c. to 2c. each.

Preparing Hard Wood for Varnish or Wax

In planing the cross grained and curly grained hard wood (and the cross grains and curls add greatly to the beauty, as well as to the value of hard wood), the plane-bit must be made much sharper and truer than for other work, not only on account of the hardness of the wood, but because the cover or breaker must be set down within a hair line of the cutting edge, thereby preventing the tearing of the grain. But even with the greatest care the plane-bit will tear slightly in very cross-grained wood—sandpaper will never smooth a torn surface—so a finer cutting tool is necessary—the cabinet scraper. This scraper, about 4 ins. long and 3 ins. wide, is made of thin saw steel. To sharpen it, the edges are first filed perfectly square, but slightly rounding from end to end, to prevent the corners digging, then rubbed with the oil-stone to take out the scratches made by the file, oil-stoned on the edges and down both sides to take off any feather edge. With a hard, smooth piece of steel (a file with the teeth ground off and the surface smoothed on the oil-stone) force the edge down, as shown in Fig.

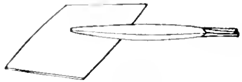


Fig. 224

224, until the edge looks like Fig. 225, *a*. Then with the same scraper steel, turn this wire edge back over the side of the scraper (Fig. 225, *b*). Hold the scraper

a *b*

Fig. 225

up high, about 30° from the vertical. If well sharpened, it will cut like the plane, and leave no torn surfaces.

Sandpaper

Sandpaper spoils much more than it helps and should be used sparingly, especially on narrow, square edges, for fear of rounding over. On large, plane surfaces it is helpful in smoothing and polishing the wood, provided the wood has been carefully scraped and planed. Sandpaper does not help rough and badly prepared surfaces, but rather adds to the poor showing of the surface. To use sandpaper in the best way, hold it in the fingers around an elastic block of rubber or cork. A block of wood makes a good sandpaper block, if two or three extra pieces are placed under the outside sheet to form a cushion.

Sandpaper is made very cheaply by machinery. A roll of paper passes under glue brushes, fastened to a large glue pot. After the surface is covered with glue, the paper passes vertically before a sand blast, which blows fine or coarse sand against the glued surface. The sanded paper then passes over hot rollers, which dry it immediately. It is then cut up into sheets or rolled up into rolls for the sandpaper machines. The cheapest quality of glue is used in the manufacture of sandpaper.

Sandpaper is made fine or coarse, from No. 000 fine, to No. 3, No. 4, or No. 5, the last number so coarse as to be almost a "garden walk."

It sells by the quire or ream in quantities, or by the sheet at ½c. to 1c. a sheet retail.

Finishing (Varnishing)

There are several methods in use to prepare the wood to receive the varnish. Raw or boiled linseed oil is sometimes used to enrich the grain before varnishing. This should be used very thin—one-half turpentine—and allowed to dry at least 24 hours.

One or two coats of thin, white shellac varnish is often used before coating with copal varnish on fine mahogany, or cherry or white maple. Brushed on carefully, allowed to dry at least 24 hours, and sandpapered very smooth with No. 00 sandpaper, this shellac varnish not only makes a beautiful, hard surface to receive the varnish, but holds the natural color of the wood, as it keeps the darker and more yellow colored copal from sinking into the grain. Varnish firms, generally, recommend this method.

Another and much used method is to fill the grain of the wood with wood filler, made of rock crystal, ground in oil. These fillers are cheap, and economical also, in saving varnish, as they fill the grain of the wood, leaving a smooth, even surface, thereby saving several coats of varnish. The filler is sold in bulk or small cans; it is thinned with turpentine until it becomes a thin paste, which can be easily applied with a varnish brush. Brush on so as to cover the surface well, and let dry only until the filler begins to turn white, when it must be rubbed off immediately, rubbing with a cloth across the grain at first, to rub the filler into the grain, then with the grain to smooth and polish. Then let dry 24 hours, and if necessary, or if specially smooth surfaces are desired, or if wax is to be used, give another coat of filler. The cloths used to rub off the filler must be spread out or burned immediately or they will take fire (spontaneous combustion). Filler is colored red for mahogany, is left white for natural wood, brown for Flemish oak, dark for antique oak or weathered oak. The saving by the use of fillers is very great, one or two coats of filler taking the place of, and saving possibly two or three coats of the more costly varnish.

STAINS

Stains are often used to color the wood before varnishing, though their use is not recommended, as stained wood always looks cheap, while there is nothing more beautiful for ornamental as well as practical purposes, than the natural color and fine grain of some beautiful wood.

Both water and oil stains are in common use, also the more costly spirit stains (alcohol). Water stain is cheaper, but as the water raises the grain, and also soaks into the end grain unevenly, its use is not recommended, though furniture men say it is more lasting than oil or spirit stain. Oil stains are now made for almost all woods, and though costing a little more, are preferable, in that they act as a wood preservative, and do not raise the grain of the wood.

To give mahogany or cherry a rich, "old" color, first stain or "age" with a solution of bicromate of potash (the red crystals) and water, and let thoroughly dry; then stain with a solution of red sanders (powdered) and grain alcohol. By diluting or strengthening these solutions, an appearance of age and richness can be given to mahogany, which is most beautiful, since the fine appearance of the wood is added to by bringing out the grain.

Care must be taken in using the red sanders stain, that it is not so strong and red as to give a "bloody" appearance. A very weak solution of the red sanders and alcohol is all that is necessary, over the potash, to give a rich color without being red.

To Stain Oak

The colored wood fillers, used chiefly on oak, because of its open grain, give antique and Flemish oak, but if special colors are desired, the Bridgeport oil stains are

recommended, and are to be applied before filling. Their "golden oak" stain, an oil stain, is to be applied with a brush, freely, let dry for only 4 or 6 minutes, then the stain is to be carefully rubbed off the lights or rays, with a soft cloth, leaving a darker background which is to be filled with golden oak or antique filler. If a specially nice job is desired, each light or ray may be sandpapered in turn, with No. 0 or No. 00 sandpaper, to remove the stain entirely (the stain does not soak into the lights), leaving the lights bright and prominent.

Another method of using the golden oak stain is to apply freely, let dry (do not rub off), apply filler, let dry only a few minutes, and in rubbing off the filler, the sharp silica crystals rub the stain off the lights, leaving them white.

VARNISH

Shellac varnish is a solution of shell-lac or lac, and alcohol, grain alcohol preferably. The securing of the lac makes an interesting story.

In South America and Africa, the bark and branches of certain species of tree are selected by a little insect as the proper place in which to lay her eggs. The insect punctures the green bark of the twigs, and deposits her eggs in the small hole made, also leaving a soft liquid on them to cover and protect them. The puncturing of the bark allows the sap to flow from the tree. This sap and the liquid left by the insect combine, and soon cover the smaller twigs and branches, very much as the limbs of trees are covered with the frozen water in winter. Beds of lac, mixed with leaves and small twigs, are often found under these trees, or even by themselves, left by the decayed trees.

This combination of sap and fluid is the crude lac. To purify it somewhat it is held over a fire, the sticky sap and fluid, in which are the insects' eggs, and often the bodies of insects themselves, running down on stones placed to receive it. It is rolled into sticks while soft, making the crude stick lac, or placed between stones and pressed flat into shells, making the crude shell-lac. This is sent to New York or to various European cities, to be purified and bleached white, making white shellac, or left unbleached, and called orange shellac. In purifying it, a beautiful red coloring matter is obtained from the bodies of the insects, and the fluid left by them, which closely resembles cochineal, the costly dyeing matter. This red coloring matter is worth so much, that the price obtained for it alone pays for the collecting, transportation and bleaching of the lac.

Shellac varnish must be brushed on quickly, since the alcohol evaporates rapidly. It must be diluted with alcohol until it flows very freely. Pure grain alcohol shellac should dry in 10 or 12 hours, but it is better to let each coat dry 24 hours. Sandpaper with No. 00 sandpaper, slightly moistened on the paper side to make it silky soft, between each coat. The sandpaper must be held in your soft hand, *never* on a block to sandpaper varnish.

White shellac varnish is much used as a "prime" for copal varnish, two coats being used, and sandpapered very smooth between coats and before using the copal.

Pure white shellac varnish is also much used to "hold the color" of light colored woods, as white maple, cherry, and sycamore, before using copal varnish. Two coats applied to these woods will retain the fresh, delicate tint of the natural wood, which would be distinctly "yellowed" if copal was used throughout for every coat.

Shellac varnish will not stand moisture, so it is seldom used to finish wood entirely, though it makes a splendid, hard surface—much harder than copal. When used alone coat from four (4) to six (6) times, until the grain of the wood is well filled, sandpapering with slightly softened sandpaper between each coat (do not sandpaper the last coat), then rub down with pumice and water or pumice and oil, as described under RUBBING DOWN.

Shellac varnish is used on floors, stairways and places requiring a very hard surface. It cannot be used outside, as it softens under moisture. It is a most convenient varnish for "quick finishing." Besides the use of shellac as a varnish to preserve and beautify wood, it is much used in the arts and manufactured articles.

Shellac varnish must be "agitated" or stirred up every day, or the parts separate, and if left but a short time in this condition cannot again be mixed to make good varnish.

Copal Varnish

Copal varnish is a compound of copal gum, boiled linseed oil, and turpentine. The copal gum is either fossilized gum from ancient buried trees, or the newer gum or resin, which flows from incisions made in certain trees in the tropics, chiefly in Africa. The gum comes to the factories in the original packages, in sacks of jute or teak casks, and is emptied on long tables and sorted, the experienced sorter judging at a glance as to the clearness, hardness or purity of the lump of gum.

The linseed oil is pressed from flaxseed, and cannot be used in its crude state, but must be boiled, usually in huge kettles holding sometimes 500 gallons. It is skimmed, tested and pumped into reservoirs, and left from one to six months to settle, brighten and work itself up to a proper degree of clearness and purity.

The turpentine is obtained by distilling the pitch of the long leaf pine tree, which grows chiefly in North Carolina, South Carolina, and Georgia. This pitch is gathered from "boxes," which are small recesses or pans chopped into the pine tree, near the ground. To make the pitch flow faster, the tree is partly girdled, cut into with an ax or hatchet to expose the inner bark, from which the pitch flows. Each year the tree is scarred or partly girdled higher up, and on another side, to obtain more pitch, but this wounding of the tree soon kills them.

The pitch is placed in a large copper vessel or still, and heated, the hot vaper from the heating passing out through a long, closed spout to the worm of the still; this worm is simply a coiled pipe in which the hot vapor is condensed into a liquid, which is the turpentine. The resin flows out from the bottom of the still.

The copal gum, the boiled linseed oil and the turpen-

tine are boiled together to make the varnish, great care being taken when the turpentine is poured into the melted gum and oil, as the fumes or gas released from the turpentine are very combustible. After boiling it is strained several times, pumped into tanks and kept from one to twelve months to ripen, some of the finest varnishes requiring even a longer time. Experts are employed, who spread the liquid varnish on surfaces, so as to judge of its value, of the flowing qualities, the thickness, the clearness, and the drying qualities. Varnishes which are not properly made or have not ripened properly, may be classed as "specky," "crawling," "sweating," "blotching," or the "peeling" and "cracking" kinds, and the more usual "blistering" kinds.

Varnish will usually behave properly and work well if used in a dry, warm, well-ventilated room, which is clean and free from dust.

Copal varnish, containing as it does a great percentage of boiled oil, should stand any climate and any amount of moisture. The fine carriage varnishes, which are exposed to all kinds of weather, are costly, from $2.00 to $6.00 or more a gallon, and each coat requires from two or three days to even a week in which to dry. The cheaper furniture varnishes cost only from $1.50 to $3.00 a gallon, and a coat will dry in from 36 to 48 hours; some much more quickly.

After the wood has been filled, or stained, or aged, or primed with the shellac varnish (these processes may be left out), the wood is ready for copal, though copal may be used alone.

The varnish is to be thin enough to flow very easily and smoothly. Varnish manufacturers claim that warming the varnish slightly is a better way to thin it than to put raw turpentine into it, as is generally done, as the turpentine destroys the smoothness and gloss of the varnish.

To Flow Copal

A heavy, thick coat is to be flowed on quickly, with a soft brush, dipped deeply into the varnish (a Fitch brush, 2 ins. wide is good), the brush is to be wiped out immediately, and the extra varnish picked up by it, again wiped out and the varnish picked up, until all the extra varnish is back in the cup, leaving only a thin, perfectly smooth surface of varnish, instead of the stringy, unequal coat, which would result if the brush were but partly filled with varnish, not enough to cover the whole surface.

This coat must dry from 24 to 48 hours; it must feel dry, not sticky (try forcing the finger nail gently into it). It is now sandpapered with No. 00 sandpaper, slightly moistened on the paper side to make it soft (the sandpaper must always be held in your hand, against the soft palm; never on a block of wood, to sandpaper varnish). If the varnish is perfectly dry it will come off on the sandpaper as a white powder; if not dry, it will come off in little black or dark spots, and should be put back on the shelf until thoroughly dry. After sandpapering, wipe or brush off carefully, to remove all dust (it is a good plan, when possible, to let the fresh sandpapered surface dry several hours).

Apply the second coat, the third and the fourth, and more, if necessary, in the same way, sandpapering between each coat, until the grain of the wood is thoroughly filled, and the varnish shows a glossy, smooth surface, allowing, if possible, a longer time to elapse after each of the latter coats, as these coats, by softening the under coats, require a longer time to dry. Do not sandpaper the last coat.

Rubbing Down with Pumice Stone

Varnish, no matter how carefully it is applied, in drying leaves little raised spots, some parts of the wood seeming to take in more than others, leaving pits. Sandpapering between each coat removes most of these raised places, and levels off the raised places even with the pits. Then, too, dust settles in the soft coats, leaving sharp points. All these inequalities of surface may be removed, and the surface made a perfect plane, ready for polishing, by cutting off the high places with powdered pumice stone, after the last coat has had time to dry thoroughly. In very fine work—piano finishing—the third or fourth coat is rubbed perfectly smooth with pumice, and then another heavy coat, or even a second of varnish is applied, which is again rubbed down, making a much smoother and more perfect plane on which to polish. The necessity of a true surface is shown in the curious effects produced by a crooked window pane, in distorting the people, houses, and streetcars seen through it. Fine mirrors, of thicker glass, are first rolled out (as are window panes), rubbed down perfectly true and smooth, then polished, then silvered, so that the true, perfect surface will reflect a perfect image. If a high polish, or even a dead finish, is desired on wood work, the same care and pains must be taken to remove all the imperfections in the surface of the varnish, even the very little pits, for when the rest of the surface is polished, these same little pits or spots seem to be magnified to twice or three times their natural size.

Pumice stone is supposed to be lava, the porous, spongelike melted rock, thrown from volcanoes. These lumps of stone were used by our great-grandmothers to whiten and clean the great stone hearths at the big open fire-places.

The pumice is carefully ground very fine for rubbing down varnish—we buy it as extra fine powdered pumice stone at 2c. a pound.

Pumice cuts faster and cleaner if used with water, but it is often used with oil, when it cuts very smoothly but more slowly.

Place the pumice in a saucer or other earthen vessel, and pour on enough water to make of the mixture a soft, thin paste. Felt is used to hold the pumice while rubbing; felt cloth, thick and soft, is much better than the thick board felt, which fills up with the pumice and water and soon becomes almost as hard as a brick, while the thick felt cloth can be kept pliable and soft. A block of wood or cork is best to use at first under the felt, as the true surface of the block helps to cut off the high places in the varnish. As soon as the surface is

somewhat smooth, the felt may be held in the bare hand, against the soft palm, the pumice seeming to cut better and faster if against an elastic or soft cushion. Examine the "rubber" of felt often, and scrape off the varnish which is cut off and accumulates in spots, which are soft, and likely to stick to the rubbed surface.

Examine the rubbed surface frequently, to see how the pumice is cutting. The pumice must be removed to see the varnish, but do not remove all; your finger, rubbed across the surface at intervals, will remove enough pumice to expose the varnish, or a piece of chamois skin is even better, as it wipes up the watery pumice perfectly dry.

Patching

In rubbing down varnish, even experienced rubbers "rub through"—that is, rub off, or cut off, all the varnish—even 5 or 6 coats—down to the bare wood, which soaks up the water and white pumice, leaving, when dry, an ugly white patch in the surface of the otherwise beautiful, smooth varnish. To patch this requires the utmost skill, as even with the greatest care the patch will show if the light is reflected across it.

First, sandpaper the bare spot gently, very gently, so as not to make a hole, to remove the raised grain of the wood caused by the water. Use No. 00 or even finer paper, and use it dry (not wet on the back).

Second, a drop of clear oil on natural wood (not stained or filled) rubbed on quickly and quickly rubbed off or wiped off, with a clean cloth, will usually make the wood look like the rest of the varnished surface (copal is almost always a little yellow). If the wood has been stained or filled apply a little of either one with a soft cloth after oiling.

Third, varnish with thin varnish, taking care not to leave a little ridge of varnish around the edge of the new coat, and varnish some distance beyond the bare wood, all around the spot upon the varnished surface, as the varnish near the bare place is very thin. Let dry 24 or 48 hours. Apply a second coat, varnishing over and quite beyond the edge of the first coat, and let dry (Fig. 226).

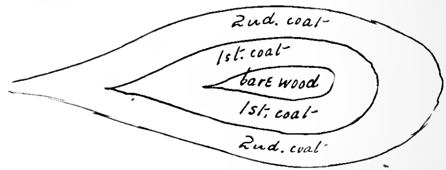


Fig. 226

Do not sandpaper between coats, for fear of scratching, with the coarse sand, the rubbed varnish near the patch.

A patch might be rubbed on two coats, with great care, but it is safer to give *three* coats before rubbing again. Apply a third coat, taking care not to leave a ridge at the edge of any coat, varnishing quite beyond the varnish of the second coat. We have covered

the wood with three coats, and the thin varnish around it with one or two coats, and are ready to rub again.

Rub with pumice and water, gently, very much water and very little pumice, taking special care to rub around the slightly ridged edges of each patched coat of varnish.

Patch copal varnish with copal varnish. Some workers believe in using shellac varnish with which to patch, as it dries more quickly. The two varnishes, copal and shellac, will not mix, one being an oil varnish and the other a spirit varnish, so the patch always shows badly if shellac is used.

Fortunately, it is nearly always sharp corners, and narrow surfaces, and little rounded edges that are rubbed through, and these patch much more easily than flat surfaces.

Polishing

The pumice stone, to cut away the surface of the varnish, must have some grit or cutting edge, which of course leaves scratches. These scratches must be removed by again rubbing with a finer stone, called rotten stone. The scratches left by the rotten stone might be removed by using a still finer stone or polishing material called rouge, used in polishing glass, but rotten stone is fine enough to give a beautiful polish to varnish, so a finer polishing material is seldom used.

Rotten stone is a soft, fine stone used in lumps, sometimes, to polish metallic surfaces, but powdered and used with oil or water to polish varnish. We buy it as finest powdered rotten stone, and it costs 4c. a pound. It is used with oil; linseed oil is the best, though a clear, smooth lubricating oil is good. The oil may be mixed with the rotten stone, and a piece of very soft cloth or fine cotton, held in the hand, used to rub it on, or a bunch of cotton or clean waste may be saturated with the oil, placed within a piece of soft cheese cloth, or other fine cloth, and this dipped into the dry powder (rotten stone).

It is said that one's soft hand is a better polisher than any other thing. Watch the polishers in any large piano wareroom or furniture wareroom, who go around all day with a piece of chamois skin on which to wipe their hands, and a little oil and rotten stone, mixed, for convenient carrying. A small quantity of the mixture is put on the piano or table and rubbed with the bare hand.

Waxing

Many years ago almost all furniture and interior wood work and floors were waxed. Then the bright varnish, which kept the wood cleaner and its natural color, by filling the pores and grains of the wood entirely, was manufactured and soon came into general use. Of late years waxed furniture has again become the style.

Our grandfathers used beeswax and other wax, cut with turpentine. Now a floor and furniture wax is manufactured, prepared ready to apply. How it is made is a secret of the manufacturers, but it probably contains boiled turpentine or oil, as it dries hard in 24 hours and will polish up brightly.

First—If stain is desired, stain with *oil* stain any color.

Second—The manufacturers of the wax polish insist that the wood must be prepared for wax quite as carefully as for varnish—that a better polished surface of wax is secured by carefully filling the wood with a good wood filler, two coats, rubbed off carefully and polished smooth.

Apply the wax with a soft cloth, as it comes as a thick paste, rubbing on only as much as the wood will take. This should dry 5 or 10 minutes, then be rubbed and polished with a soft cloth, and let dry 24 hours.

The second coat is rubbed on like the first. Let dry 10 or 15 minutes, then polish with a soft cloth. After drying 24 hours the waxed surface should not show finger marks.

More than two coats are hardly necessary at one time. Not being so durable as varnish, it is just as well to use the article waxed, until it needs another coat, then refinish with a new coat.

Cracking and Blistering

If the varnish cracks while drying or rubbing, scrape it off with a very sharp chisel, held straight up in the hand, sandpaper and revarnish.

If cracks appear after some months or years of use, a good, soft oil, rubbed over the varnish, will help to close the cracks temporarily, by giving back to the varnish new life, which has either evaporated or been dried out by the heat of the room. But nothing can restore the perfect surface; the cracks will appear as soon as the oil has dried out. New coats of varnish do not fill up cracks—the cracks showing through the new coats—so there is no remedy but to scrape off the varnish and apply a better article.

If the varnish blisters, scrape it off immediately, and apply another kind, or change the temperature of the room, when there may be no more trouble. But it is a fact that one article will blister, and another, made of the same wood, varnished with the same varnish, at the same time, in the same room, will not blister—why, no one knows.

It is better to pay for a good grade of varnish, which is higher priced just because it is more carefully made, strained and allowed to settle and work itself out for a longer time than the cheaper grades.

A good plan for beginners is to prepare small, smooth pieces of wood, and practice "flowing" (coating) the varnish, rubbing down, patching, and polishing.

Waxing is such a simple process, that merely following the directions given will surely give good results.

GLOVE BOX

(Lined with Silk)

STOCK BILL

2 P—$12\frac{5}{8}$"x3"x$\frac{5}{16}$"—sides.
4 P—1"x3"x$\frac{1}{2}$"—blocks to glue on sides.
2 P—$2\frac{1}{2}$"x3"x$\frac{5}{16}$"—ends.
2 P—$13\frac{3}{8}$"x5"x$\frac{5}{16}$"—top and bottom.

NOTE (1).—Top is planed slightly smaller after gluing on.

NOTE (2).—The inside dimensions of this box may be changed to the following sizes, all of which have been made, and look well:

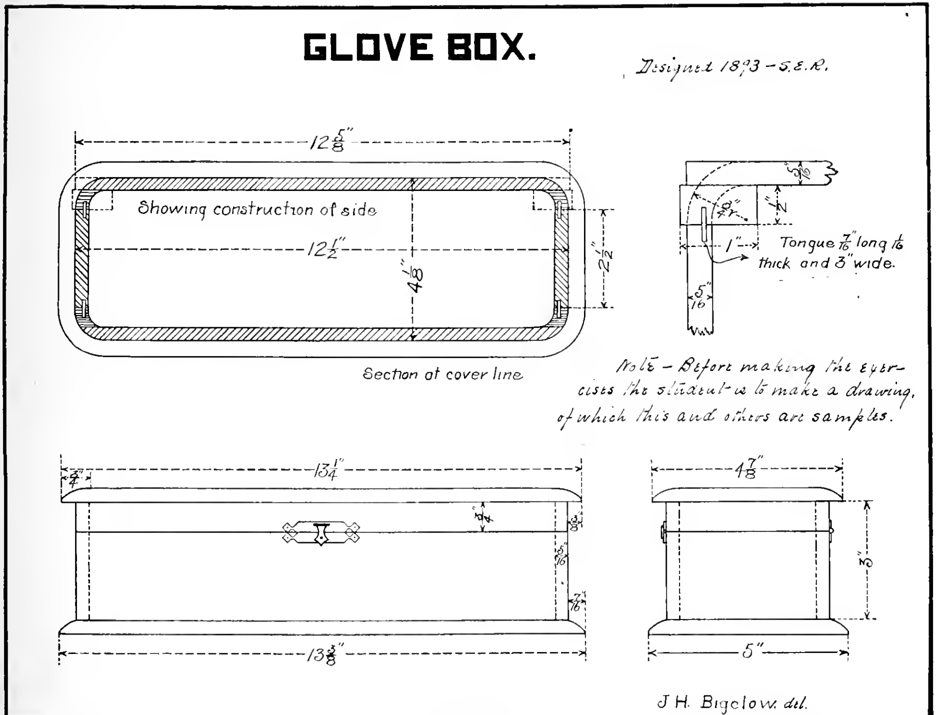

GLOVE BOX.
Designed 1893 – S.E.R.
12 5/8"
Showing construction of side
12 1/2"
4 1/8"
2 1/2"
Section at cover line
Tongue 7/16" long 1/8 thick and 3" wide.
1"
5/16"
5/16
Note – Before making the exercises the student is to make a drawing, of which this and others are samples.
13 1/4"
3/4"
13 3/8"
4 7/8"
3"
5"
7/16
J H. Bigelow. del.

Fig. 227

12″x8″x3½″ deep inside.
18″x8″x3½″ " "
or square—6″x6″x3″ " "

Directions

1. Warm the wood in oven, and glue the ½ in. thick blocks on the sides. Groove the sides and ends, and glue the tongues in the end pieces, pounding them in gently with the hammer. Let dry 2 hours.
2. Fit the ends into the grooves in the sides, marking each fitted corner, No. 1, No. 1, or No. 2, No. 2, etc., clamp up dry in hand screws (without glue) and show your instructor, and receive his permission to glue sides and ends together.
3. Warm the wood in the oven, glue up with hot glue—clamping with hand screws—square your box with try-square, and let dry 2 hours.
4. Joint both the top and bottom edges of your box, and show your instructor.

   Mark off the *outside* round corners of your box with dividers, and saw at band saw or with back saw, sawing outside the lines.

   Plane off the faces of the sides and ends, first, perfectly true and smooth, then plane the round corners, planing across the grain, but with the plane held at 45° to the grain.

   Show to your instructor before sandpapering, then sandpaper with No. ½ or No. 1 sandpaper, held with your fingers on a block about 4 ins.x 2½ ins.
5. Place the box first on the top piece, then on the bottom piece, marking the outside and inside shapes on both pieces. Mark out the projecting molding at corners, and saw at band saw or with back saw.

   Plane edges of top and bottom pieces to required shape, leaving most of the molding on the top to be planed after it is glued on. Set small brads in inside face of top and bottom, on lines marked out, to hold these pieces in position while gluing.
6. Saw out the inside corners of box on scroll saw, or chisel them out with the pattern maker's gouges, sandpapering the corners with the paper held on a round stick (a ½ in. dowel).
7. Warm the top and bottom in oven, and glue on with hot glue, clamping with hand screws. Let dry 2 hours.
8. Cut glue from corners with sharp chisel, cutting across the grain, always, never with the grain.

   Plane the outside of the bottom and top perfectly true and smooth, finishing the top molding back ¾ in. from edge.

   Spoke-shave the corners until all are matched, and plane the projecting moldings, until all projections are equal.

   Show to your instructor before sandpapering, then sandpaper the moldings with folded paper held in your hand. Hold the sandpaper on a sharp, square block to clean out and smooth the corners.

9. Stain or fill with the desired color of stain or filler, or if natural, varnish or wax, following the directions for FINISHING.
10. Saw open $\frac{3}{4}$ in. down from the top, and plane the edges carefully, until the cover fits the box perfectly. Sandpaper the edges gently with No. 0 sandpaper, then varnish the edges with one coat only of thin shellac varnish, or if wax is used, wax the edges.
11. Screw on the hinges 2 ins. from either end, and the clasp in the center.

Lining with Silk

12. Cut 1 in. wide ribbon hinges 4 ins. long, and glue on over the hinges on inside of box.
13. Cut white paper the exact width of the depth of box, and 2 ins. longer than the distance around the inside; also paper the exact width of the depth of the cover ($\frac{3}{4}$ in.) and 2 ins. longer than the distance around the inside; also paper the exact length and width of top and bottom inside.
14. Cut the silk 1 in. wider than the long strips, fold one end of the silk in $\frac{1}{4}$ in., lay paper on the fold and on the silk, glue the paper slightly (all but the folded silk end) and fold the silk tightly over the paper. Insert the frayed end into the folded end, and the piece is ready to glue in the box.

Prepare the other pieces, using one or two layers of cotton wadding to soften the top and bottom pieces, under the silk, also sachet powder next the paper and under the cotton, so that it will not show through the bottom piece of silk.

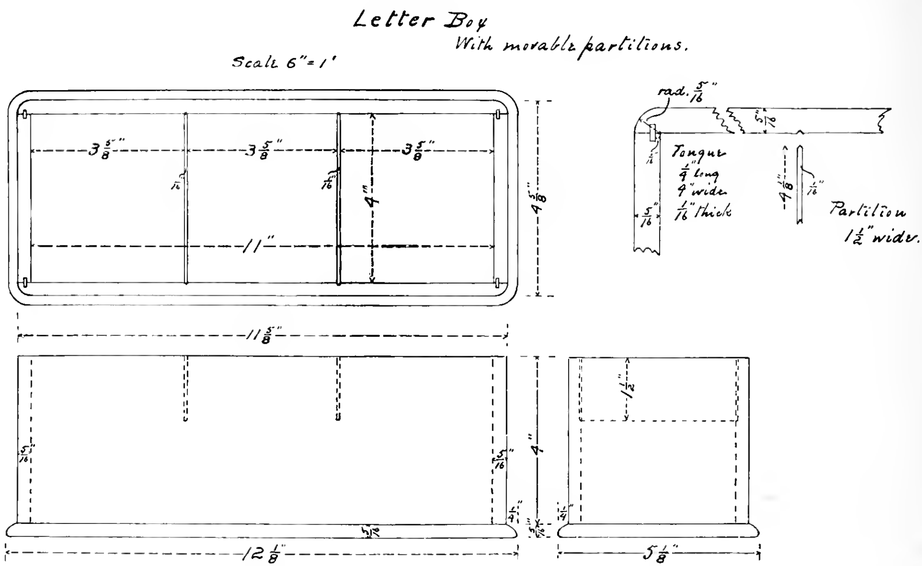
15. When the pieces of silk are all prepared, glue around the edges of the inside of the box—$\frac{1}{4}$ in. only back from edges—excepting over the ribbon hinges, where more glue may be used. By gluing the folded end of the strips of silk to the front side of the box the fold does not show.

Four daubs of glue near the corners are sufficient to hold in the top and bottom; the less glue, the less contracting of the paper.

LETTER BOX

1. Glue tongues or splines into ends, pounding them in gently with hammer. Let dry 2 hours.
2. Plane inside face of each piece, including the bottom, perfectly smooth and true.
3. Fit the ends into the grooves in the sides, numbering each fitted corner No. 1, No. 1, or No. 2, No. 2—clamp up *dry* in hand screws (without glue). Show to your instructor and receive his permission to glue sides and ends together.
4. Warm your wood in oven, glue up with hot glue, clamping with hand screws, square your box with try-square, and let dry 2 hours.
5. Joint both the top and bottom edges of your box, and show to your instructor. Mark off the round corners with the dividers, and saw at band saw or with back saw, keeping outside the line.

Plane off the faces of the sides and ends, first, per-



Stock Bill —
- 2 P = 11 5/8" x 4" x 5/16" - sides.
- 2 P = 4" x 4" x 5/16" - ends.
- 1 P = 12 1/8" x 4 5/8" x 5/16" - bottom
- 2 P = 4 1/8" x 1 1/2" x 1/16" - partitions.
- 4 P = 1/4" x 4" x 1/16" - tongues.

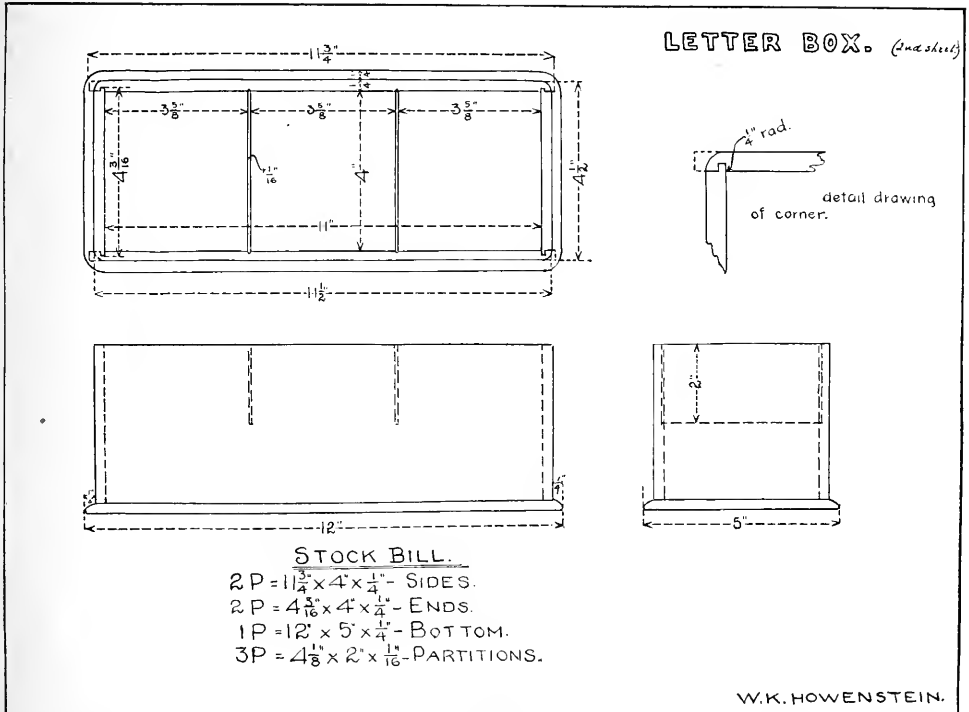

LETTER BOX. (2nd sheet)
$11\frac{3}{4}''$
$\frac{1}{4}''$
$3\frac{5}{8}''$
$3\frac{5}{8}''$
$3\frac{5}{8}''$
$4\frac{3}{16}''$
$\frac{1}{16}''$
$4''$
$4\frac{1}{2}''$
$11''$
$11\frac{1}{2}''$
$\frac{1}{4}''$ rad.
detail drawing of corner.
$2''$
$12''$
$5''$
STOCK BILL.
2 P = $11\frac{3}{4}'' \times 4'' \times \frac{1}{4}''$ - SIDES.
2 P = $4\frac{3}{16}'' \times 4'' \times \frac{1}{4}''$ - ENDS.
1 P = $12'' \times 5'' \times \frac{1}{4}''$ - BOTTOM.
3 P = $4\frac{1}{8}'' \times 2'' \times \frac{1}{16}''$ - PARTITIONS.
W. K. HOWENSTEIN.

Fig. 229

fectly true and smooth, then round the corners, planing across the grain, with the plane held at 45° to the grain. Show to your instructor before sandpapering, then sandpaper with No. ½ or No. 1 sandpaper, held with your fingers on a sandpaper block about 4 ins. long and 2½ ins. wide.

6. Place the box on the bottom piece, and mark off the outside edge and inside of box on the bottom. Mark off the projecting molding at corners, and saw at the band saw or with back saw. Plane off edges of bottom to required shape, set small brads in bottom piece on the inside line of box, to hold bottom in position while gluing. Warm bottom piece only, and glue on with hot glue, clamping with hand screws. Let dry 2 hours.
7. Cut glue from corners with a sharp chisel, cutting across the grain always (never with the grain). Plane the lower side of the bottom perfectly true and smooth, and sandpaper. Sandpaper the molding with folded paper held in your hand. Hold the sandpaper on a sharp, square block, to clean out and smooth corner above molding.
8. Cut the grooves for the partitions with a V carving tool, and plane and fit the partitions.
9. Stain or fill with the desired color of stain or filler, following the directions for Finishing.

OCTAGONAL TABORET

1. Glue up top of taboret and let dry for several days, or while making the base.
2. Plane the eight side pieces to dimensions, bevel the edges, mark out shape with the pattern, nail four pieces together to saw out shape—nailing, of course, through the parts to be thrown away. Groove the edges, and prepare at least 3 narrow tongues, for each joint; not to strengthen the joint, but to prevent the pieces sliding past each other while gluing.

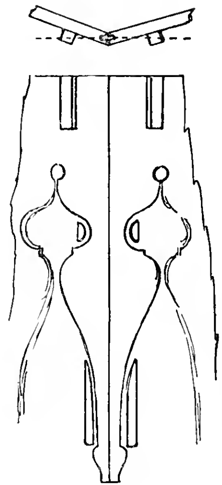


Fig. 230

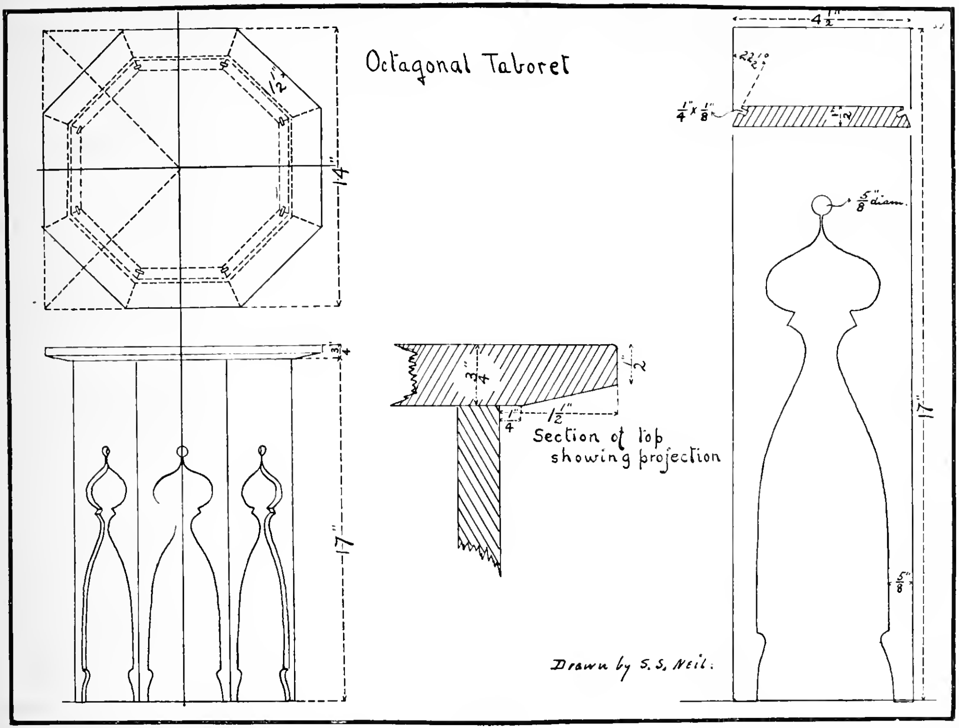

Octagonal Taboret
Section of Top showing projection
Drawn by S. S. Neil.

Fig. 231

3. Glue on blocks, when necessary, for the hand screws, as shown (Fig. 230), rubbing on the blocks with hot glue. Let dry 2 or 3 hours.

   Prepare soft pine blocks to fit in the curved shapes of the sides, as shown, for hand screws; also soft pine sticks for hand screws, to preserve the corners on narrow legs, as shown.

4. Warm the sides in oven, and glue up in pairs—two and two—wipe off glue on inside with hot, wet cloth, and let dry 2 hours. Glue up the pairs, wipe off glue, and let dry 2 hours.

5. Mallet and chisel off the glue blocks, until within $\frac{1}{16}$ in. of sides, then plane all faces perfectly true and smooth.

6. Joint off top edge; glue on 4 glue blocks—3 ins. x $1\frac{1}{2}$ ins. x $\frac{7}{8}$ in.—to take screws to screw on top. Bore a hole in each block to receive screws.

7. Plane the top perfectly true and smooth, bevel the edges, sandpaper with No. $\frac{1}{2}$ or No. 1 paper, hold top in position with hand screws, and *screw* it on with flat-head screws. Never glue on the tops—table tops are screwed on, not glued.

8. Follow directions for FINISHING.

HAND MIRROR

1. Mark out opening for glass, and saw at scroll saw, or with little hand saw.

2. With a gauge having a long, sharp point, gauge a deep line half way down the thickness of the material, and also $\frac{3}{16}$ in. back from edge of opening, and chisel out the square "rabbet" for mirror.

3. Mark out outside of frame and handle, making the handle long or short as desired, and saw at band saw. File rough edges with fine wood file, taking special care to file out any imperfect curves in outline.

4. Spoke-shave the face of frame to shape shown in drawing—the arc of a circle, with sharp corners at edges.

   With a V carving tool, V down the center line of handle, making a much shallower V around the lap over at both ends. With the flat gouge, round over the handle to shape shown in section—the arc of a circle, with sharp corners at edges.

   Shape both sides of handle, but only the upper face of frame.

   Show to your instructor before sandpapering (do not sandpaper until carving is completed), then sandpaper with No. $\frac{1}{2}$ or No. 1 sandpaper.

5. Mark out the thin back of frame, saw at band saw, file or spoke-shave the edge, rounding it over very slightly. Plane the inside surface perfectly true, to make a good glue joint with frame.

6. Finishing. Shellac varnish or wax will be better to finish with than copal. Apply wax or shellac varnish as directed under FINISHING, taking

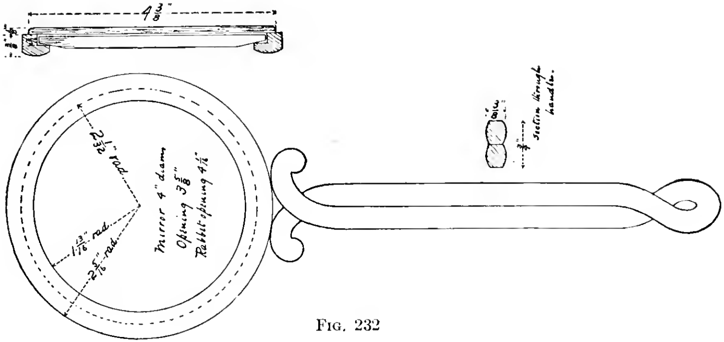


FIG. 232

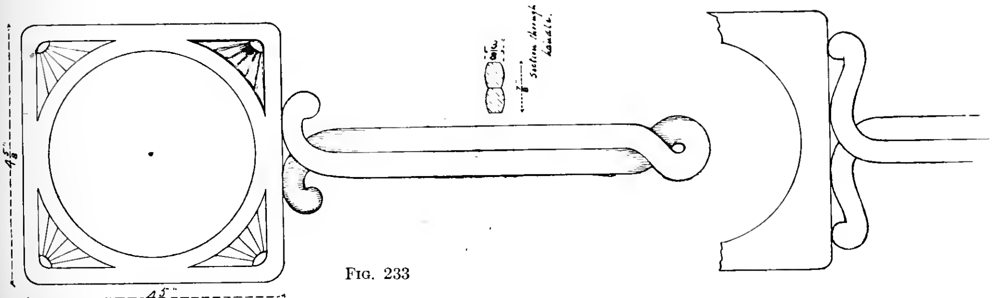


FIG. 233

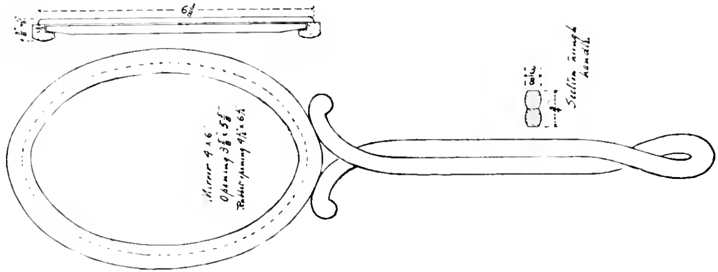


FIG. 234

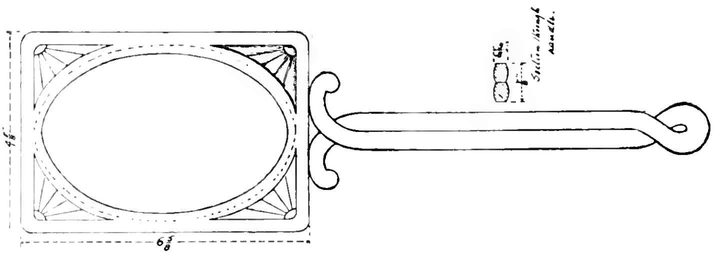


FIG. 235

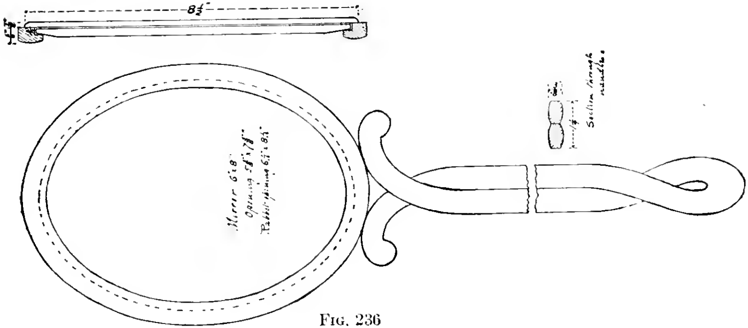


FIG. 236

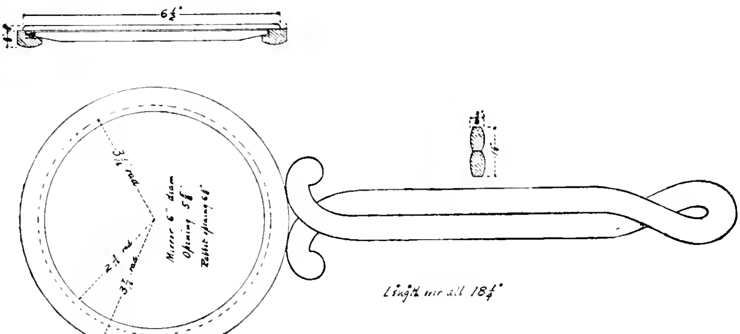


FIG. 237

care not to varnish or wax the *inside* of the thin back board, or the frame next the rabbet, as the glue will not hold if the grain of the wood is filled with wax or varnish.

Rub down and polish the whole frame and handle, then fasten and glue in the mirror by using little triangular glue blocks (Fig. 238). Plane or

FIG. 238

chisel these off flush with the surface, lay one or two thicknesses of cotton wadding on back side of mirror, and glue the thin wood back in place.

The front of the frame and the back of the back will not be injured by the hand screws if smooth, soft pine boards are laid against each face.

Cut glue out of corners with sharp chisel, sandpaper gently, and refinish the back.

The finishing could not be done with the mirror in place, as any rubbing of the mirror will dull the polish.

Waxing would not hurt the mirror, but the wood-filler used to prepare the wood for the wax would scratch the mirror, so it is better to finish the front and edges of the frame and the handle before fastening the mirror in place.

OCTAGONAL TABORET

To lay out an octagon, take half the diagonal of the square and mark it off on the sides of the square.

Bevel the edges of the sides before sawing out at band saw, then nail three or four sides together and saw, then file edges true and smooth (Fig. 239).

Glue on blocks at top end of sides to take hand screws, and prepare soft pine blocks, shaped to curves of sides, to prevent hand screws from marring edges, while gluing up (Fig. 240).

Glue up sides in pairs, two and two, and let dry 2 hours, removing glue from inside corners, immediately, with cloth wrung out of hot water. When dry, glue up pairs, removing the glue carefully.

Glue on 4 blocks, on opposite sides, flush with top edge—blocks to be about 3 ins. x $1\frac{1}{2}$ ins. x 1 in.—to hold screws, with which the top is screwed on.

Plane the top smooth and true, bevel the edges (Fig. 241), and sandpaper, before screwing down (the top must be held in position, while screwing, by four or more hand screws).

Stain or fill the desired color, and wax or varnish, following directions under FINISHING.

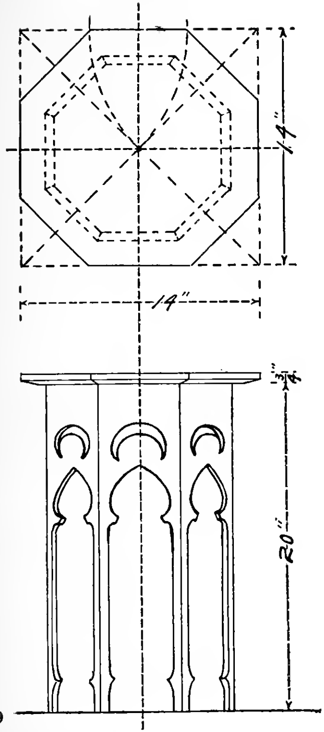


FIG. 239

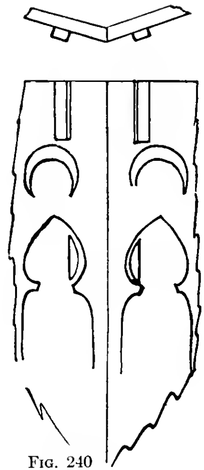


FIG. 240

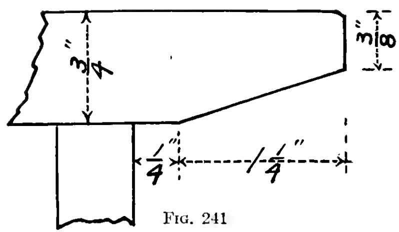


FIG. 241

SQUARE TABORET

By using pattern for leg (Fig. 242) on board 22 ins. x $5\frac{1}{2}$ ins. x $\frac{1}{2}$ in., much material may be saved. Nail three or four pieces together, saw out shapes on band saw, and file edges true and smooth.

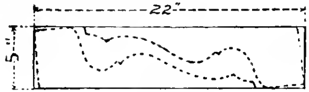


Fig. 242

With large iron square lay out on bench top lightly, with soft lead pencil, the center line *a*, *b*, 17 ins. long, the

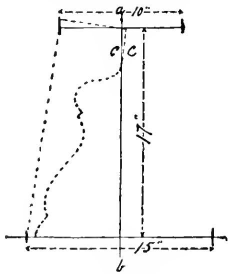
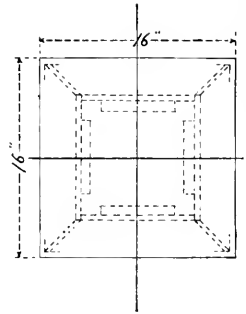


Fig. 243

true length of the side. Lay off the width of the bottom of the side 15 ins., and the width of the top of the side 10 ins. (Fig. 243).

Plane and fit the joint at *cc*, of the two pieces of the side, and glue together. Saw the top edge of the side



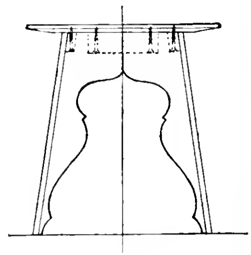


Fig. 244

straight. Plane both faces of the sides smooth, and glue on inside of the top edge a glue block 6 ins. x 2 ins. x 1 in., both to strengthen the side at the joint, and to serve to hold the screws with which the top is screwed on (table and taboret tops are screwed on, not glued).

Two of the sides of the taboret will be twice the thickness of the material narrower than the other two (Fig. 244).

Glue sides together with hot glue, using iron clamp and hand screws, with soft pine blocks shaped to the curves of the legs, so as not to mar the edges.

Bevel the under side of the top and screw it on, holding it in place with hand screws while screwing it down.

Stain or fill with the desired color of stain and filler, and wax or varnish, following directions under FINISHING.

SMALL TABLE

(With Shaped Legs—Fig. 245)

The stock for the legs must be 14 ins. x 2 ins. x 2 ins., and with a straight shoulder for rail of 2 ins., and the curve to begin $\frac{3}{4}$ in. back from the shoulder (Fig. 246, *a*).

With these dimensions given, each boy is to make a pattern, full size, of the leg, subject to the criticism of his instructor.

The legs may be left straight from the knee up, to give a good hold to the clamps (Fig. 246, *b*).

A better way is to saw out the leg completely and shape and smooth it with the spoke-shave, with the exception of rounding over the outside corner.

Saw out and shape the rails also, and glue two dowels

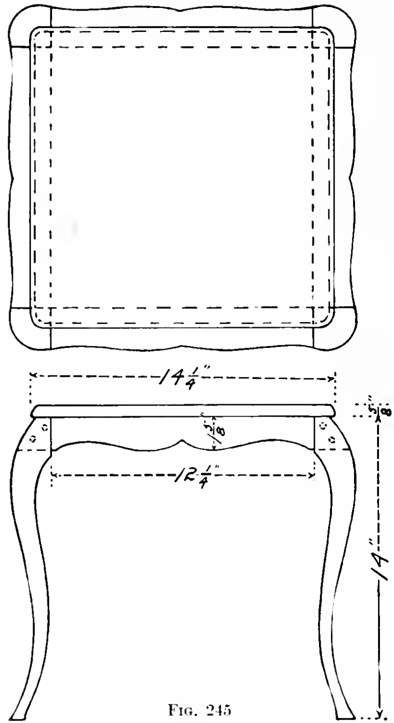


FIG. 245

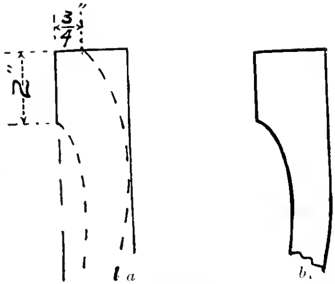


FIG. 246

into ends of each rail, and when ready to clamp up, saw a block at the band saw to fit the knee, and fasten on with a hand screw (Fig. 247).

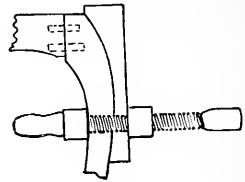


FIG. 247

The rail should be doweled in so as to remain a little above the curve of the leg, that the rail may be planed off flush with the leg, after gluing. By gluing up the legs in pairs, this planing may be easily done on two rails, the other two requiring more care, as the table is then all clamped together.

The molding on the top is a regular table top molding, simple and beautiful, though in this case it is turned over.

The regular table top molding is shown in Fig. 248, but to complete the curve begun by the leg, the whole top is turned over.


FIG. 248

Screw down the top with two wood screws in each rail Fig. 249).

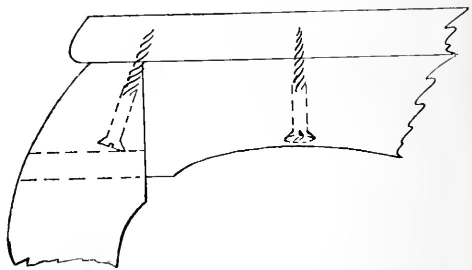


FIG. 249

HAT FRAME

(Mirror 8 ins. x 24 ins.)

NOTE.—Mirror may be 8 ins. x 28 ins. or 8 ins. x 36 ins., in the use of which one or two more hat hooks may be fastened to the lower side of the frame.

Oxidized, nickeled or brass hat hooks.

If mirror is 8 ins. x 24 ins., the "opening" of the frame is 7¼ ins. x 23¼ ins., allowing ⅜ in. of glass covered all around in rabbet (the rabbet is the part cut from the inside edge of the frame, to take the mirror—½ in. x ½ in.).

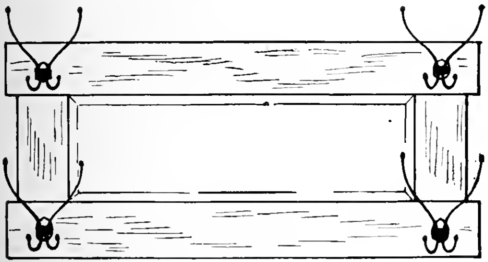


FIG. 250

If the top and bottom pieces of the frame extend ¾ in. beyond the end pieces, the stock bill reads:

2 P—31¾"x3½"x⅞"—top and bottom pieces.
2 P—7¼"x3½"x⅞"—ends.
1 P—9½"x25½"x¼" or ⅜"—glass back.
- P—1½"x¼"x¼"—triangular blocks to glue around mirror (pine).

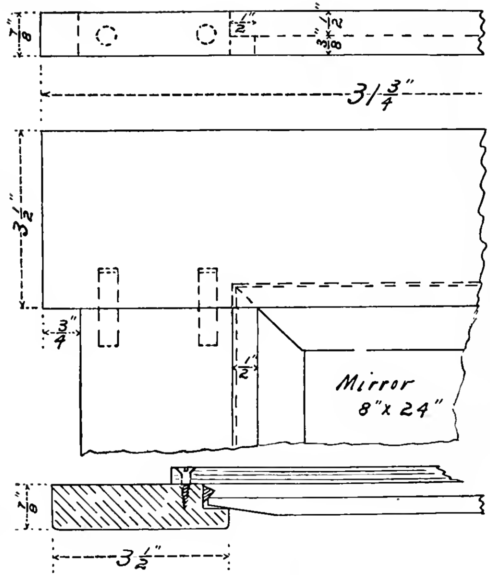


FIG. 251

To construct—Plane inside and outside edges of pieces perfectly square and smooth.

Joint the ends of the end pieces square. Mark off the position of the end pieces on the top and bottom pieces of the frame.

Number the corners of the frame, 1, 1; 2, 2, etc.

Lay out dowel hole centers (Fig. 252), drive small wire brads into center marks, and cut off brads so that they will project $\frac{1}{16}$ in.

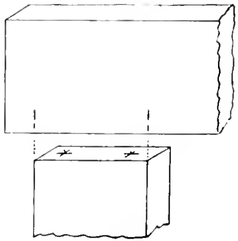


Fig. 252

Push the ends with the projecting points against the sides exactly in the proper place. Pull out the brads, and bore holes $\frac{3}{4}$ in. deep, with $\frac{3}{8}$ in. or $\frac{7}{16}$ in. bit.

Glue the dowels into the end pieces, putting the glue into the hole which is to receive the dowel with a round stick somewhat smaller in diameter than the hole. Never dip the dowel in the glue. Dowels should be partly sharpened or pointed with the dowel pointer, to prevent the glue being pushed ahead of the dowel by the square end.

Fit the end pieces into the sides—dry, without glue—clamping up the frame with the iron clamps—dry—to see that all the joints are perfect. The dowels should project $\frac{1}{8}$ in. less than the hole is deep.

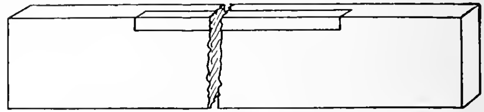


Fig. 253

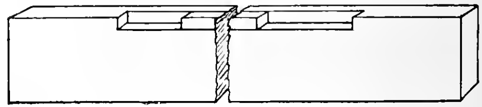


Fig. 254

Cutting the rabbet—If the rabbet for the glass is to be made by hand, gauge deeply along the two edges of the rabbet (Fig. 253), cut out the two ends of the rabbet with the chisel (Fig. 254), and plane the remaining part with the rabbet plane (Fig. 255), a narrow wood

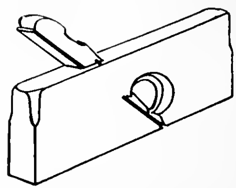


Fig. 255

plane, with the bit the full width of the plane. Plane the rabbet in the two end pieces, warm the parts of the frame in the warming oven, and glue the frame together, using plenty of glue on the end joints.

Plane the face and back sides of the frame perfectly true and smooth, and round the outside and inside corners of the top face $\frac{1}{16}$ in. only.

Finish with wax or varnish, following directions under FINISHING.

Place the mirror in position and glue around the edges triangular pine blocks, about $1\frac{1}{2}$ ins. long, which have been planed on one edge to make a joint (Fig. 251).

When dry screw down the glass back to protect the mirror.

To fasten to the wall, screw to the back of the frame two blocks, the thickness of the back-board, and to these blocks screw two thin plates of brass, bought in any hardware store.

The hat hooks should be perfectly plain to look well—round nickel-plated, or oxidized, if desired.

Mitered Frame for Mirror, 12 ins. x 18 ins.

The frame opening will be $11\frac{1}{4}$ ins. x $17\frac{1}{4}$ ins., allowing $\frac{3}{8}$ in. of glass covered all around in rabbet (Fig. 256).

If the material is $3\frac{1}{2}$ ins. wide, the stock bill reads:

2 P—$24\frac{1}{4}''$x$3\frac{1}{2}''$x$\frac{7}{8}''$
2 P—$18\frac{1}{4}''$x$3\frac{1}{2}''$x$\frac{7}{8}''$
1 P—$13\frac{1}{2}''$x$19\frac{1}{2}''$x$\frac{1}{4}''$ or $\frac{3}{8}''$ glass back.

Plane inside edges of pieces perfectly square and smooth.

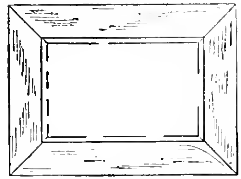


FIG. 256

Lay out pieces, with bevel set to 45°.

Number the pieces at the corners—1, 1; 2, 2, etc.

The miters may be planed in the vise, but a much easier way is to plane them in the bench hook, against a 45° block (Fig. 258). Try each one of the four corners of the frame with the try-square to prove the miter joint.

Plane the rabbet $\frac{1}{2}$ in. x $\frac{1}{2}$ in. in each piece, with the rabbet plane. Lay out dowel hole centers in end pieces and drive small wire brads into centers, cutting off brads to project only $\frac{1}{16}$ in.

Carefully mark out dowel hole centers in top and bottom pieces by pressing end pieces against them in the proper place, pull out brads and bore for dowels with $\frac{3}{8}$ in. or $\frac{7}{16}$ in. bit.

Glue the dowels in end pieces, putting glue into the hole to receive the dowel (do not glue the dowel). Saw off dowels $\frac{1}{8}$ in. shorter than holes are deep, fit each corner and clamp together dry, without glue.

Mitered frames may be clamped up in two ways: 4 hand clamps may be used, extending clear over the

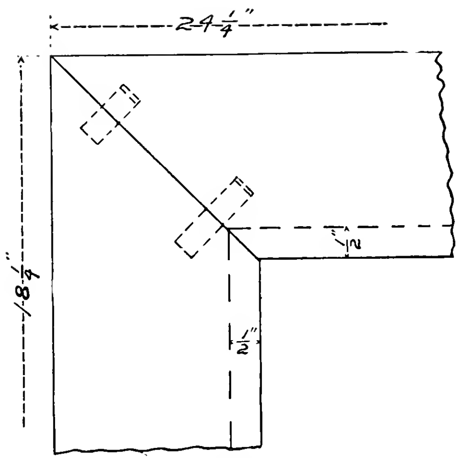
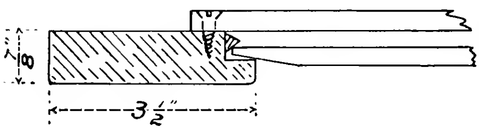


FIG. 257



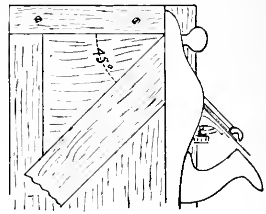


FIG. 258

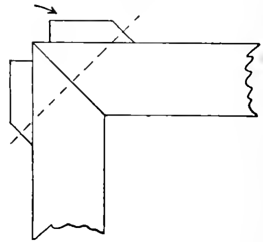


FIG. 259

frame, or glue blocks may be rubbed on the outside edges of the mitered pieces near the corners (Fig. 259). These glue blocks must be quite long, that a good glue joint may be made, to withstand the strain of the hand screw, and they must be mitered at inside end to receive the hand screw, and they should be glued on in such a position that the hand screw will force the joint together about midway of the miter (see dotted line).

Warm the pieces in the heating oven, and glue together, using plenty of warm, thin glue on miters.

Chisel off blocks carefully and plane front and back faces perfectly true and smooth; also square up outside edge.

Finish in wax or varnish, as directed in FINISHING.

Place mirror in position, and glue in place with triangular pine blocks, one edge of which has been planed to make a joint.

To fasten to wall, screw to back of frame two thin brass strips, or use screw eyes and picture wire.

This frame may be used as a hat frame by the addition of hat hooks.

MAGAZINE HOLDER

(With shaped ends)

A rack to hold three magazines, side by side, will require 22 ins. between end pieces—four magazines, 29 ins. (Fig. 260).

STOCK BILL

2 P—17″x3″x$\frac{1}{2}$″—ends.
3 P—23$\frac{1}{2}$″x2$\frac{1}{2}$″x$\frac{5}{16}$″—back strips.
2 P—23$\frac{1}{2}$″x1$\frac{3}{4}$″x$\frac{5}{16}$″—front strips.
1 P—24$\frac{1}{2}$″x3″x$\frac{1}{2}$″—shelf.
4 P—1″x$\frac{3}{8}$″x$\frac{1}{2}$″—wedges.

The back strips are to be gained in, or let in, their full thickness into the back edge of the end pieces, and are to project $\frac{1}{4}$ in. at either end.

These strips are to be screwed on.

The front strips are to be screwed on with round-headed screws, and are also to project $\frac{1}{4}$ in. over end pieces at either end.

The bottom shelf is 3 ins. wide and may be tenoned and driven through mortises in the end pieces and wedged; or it may be cut off the exact length—22 ins.—between end pieces, and screwed on with flat-headed screws through the ends.

The projecting ends and wedges are then made separately, and glued and nailed on.

This is the usual way of making "Old Mission" furniture, with projecting tenons and wedges.

Stain or fill the desired color, and follow directions under FINISHING.

To fasten to wall, screw into the back of the end pieces at the top two thin, flat brass plates, containing three holes for screws.

Magazine Holder—Old Mission Style

A rack to hold three magazines, side by side, will require 22 ins. between end pieces—4 magazines, 29 ins. (Fig. 261).

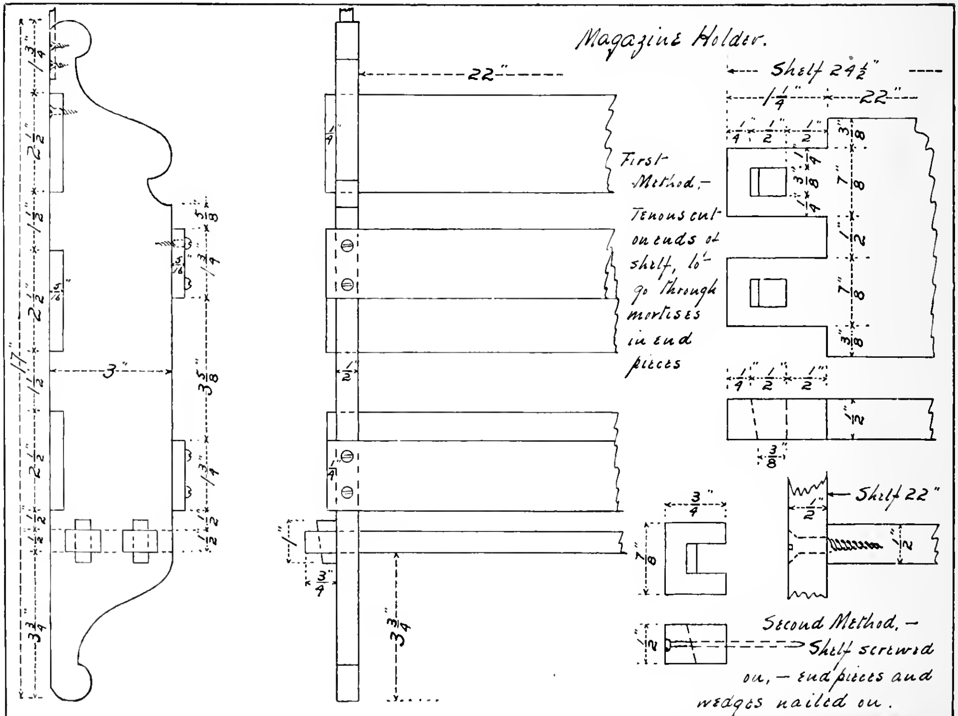
STOCK BILL

2 P—13$\frac{1}{2}$x3″x$\frac{1}{2}$″—ends.
5 P—23$\frac{1}{2}$″x1$\frac{3}{4}$″x$\frac{5}{16}$″—front and back strips.
1 P—24$\frac{1}{2}$″x3″x$\frac{1}{2}$″—shelf.
4 P—1″x$\frac{1}{2}$″x$\frac{3}{8}$″—wedges.

The back strips are to be let in, or gained in, their full thickness into the back edge of the end pieces, and are to project $\frac{1}{4}$ in. at either end.

These strips are to be screwed on.

The front strips are to be screwed on with round-



Magazine Holder.
Shelf 24½"
22"
First Method.— Tenons cut on ends of shelf, to go through mortises in end pieces
Shelf 22"
Second Method.— Shelf screwed on,— end pieces and wedges nailed on.

FIG. 260

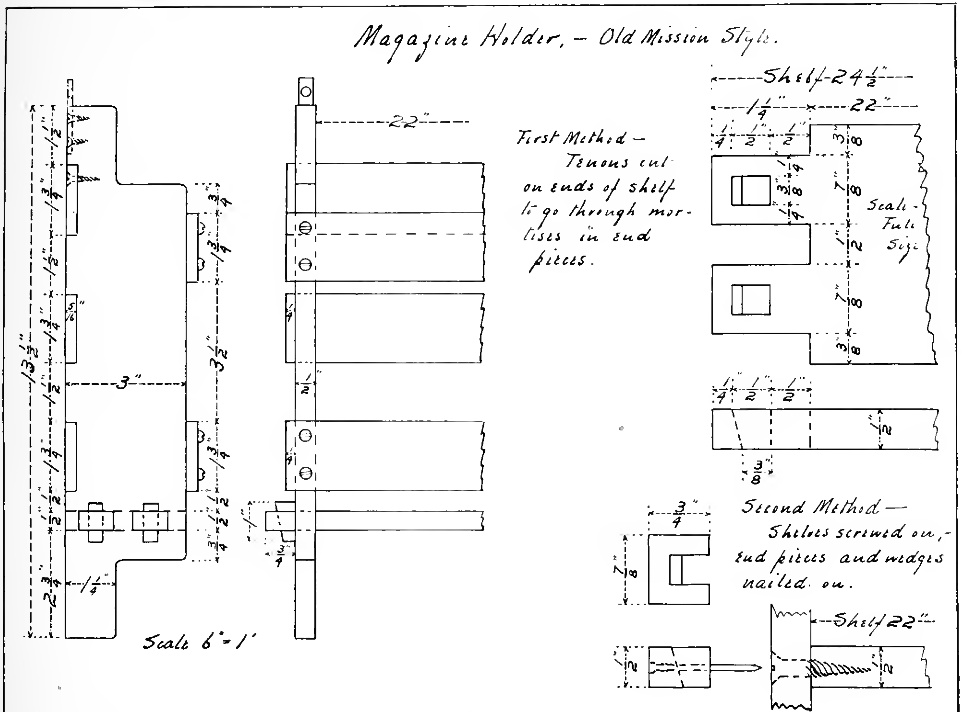

Magazine Holder, – Old Mission Style.
Shelf 24 1/2"
1 1/4"
22"
First Method –
Tenons cut on ends of shelf to go through mortises in end pieces.
Scale - Full Size
3"
3 1/2"
13 1/2"
1 1/4"
Scale 6" = 1'
Second Method –
Shelves screwed on, – end pieces and wedges nailed on.
Shelf 22"

Fig. 261

headed screws, and are also to project $\frac{1}{4}$ in. over end pieces at either end.

The bottom shelf is 3 ins. wide, and may be tenoned and driven through mortises in the end pieces, and wedged, or it may be cut off the exact length—22 ins.—between end pieces, and screwed on with flat-headed screws through the ends.

The projecting ends and wedges are then made separately, and glued and nailed on.

This is the usual way of making "Old Mission" furniture, with projecting ends and wedges.

Stain or fill the desired color, and follow directions under FINISHING.

To fasten to wall, screw into the back edge of the end pieces at the top two thin brass plates, having holes for screws.

PLATE RACK WITH TOP SHELF

(Fig. 262)

STOCK BILL

2 P—17$\frac{1}{2}$"x4"x$\frac{1}{2}$"—end pieces.
1 P—36"x4"x$\frac{1}{2}$"—top shelf.
1 P—34$\frac{1}{2}$"x2$\frac{1}{4}$"x$\frac{1}{2}$"—lower shelf.
1 P—33$\frac{1}{2}$"x1"x$\frac{5}{16}$"—back strip.
1 P—33$\frac{1}{2}$"x2"x$\frac{5}{16}$"—back strip.
2 P—1"x$\frac{3}{8}$"x$\frac{1}{2}$"—wedges.

The back strips are to be gained, or let in, their full thickness, into the back edge of the end pieces, and are to project $\frac{1}{4}$ in. at either end. These strips are screwed to the end pieces, and may be glued to the shelves.

The top shelf is doweled on. To mark off for dowel holes, drive two small brads in the top ends of the end pieces, cut off to project only $\frac{1}{16}$ in., and push into top shelf in proper place. Pull out brads and bore with $\frac{5}{16}$ in. or $\frac{3}{8}$ in. dowel bit.

The lower shelf may be tenoned and driven through a mortise in the end pieces, and wedged, or it may be cut off the exact length—32 ins.—between the end pieces, and screwed on with flat-headed screws through the end pieces. The projecting pieces and wedges are made separately, and glued and nailed on.

The lower shelf is to be grooved along the front edge to hold plates securely.

Stain or fill the desired color, and wax or varnish, following directions under FINISHING.

To fasten to wall, screw into the back of the end pieces at the top two thin brass plates, containing three holes for screws.

Small hooks are screwed into lower shelf, from which teacups are suspended.

NOTE.—Top shelf may be grooved also to hold both plates and vases.

PLATE RACK

A rack to hold three medium-sized plates will require 32 ins. between end pieces (Fig. 263).

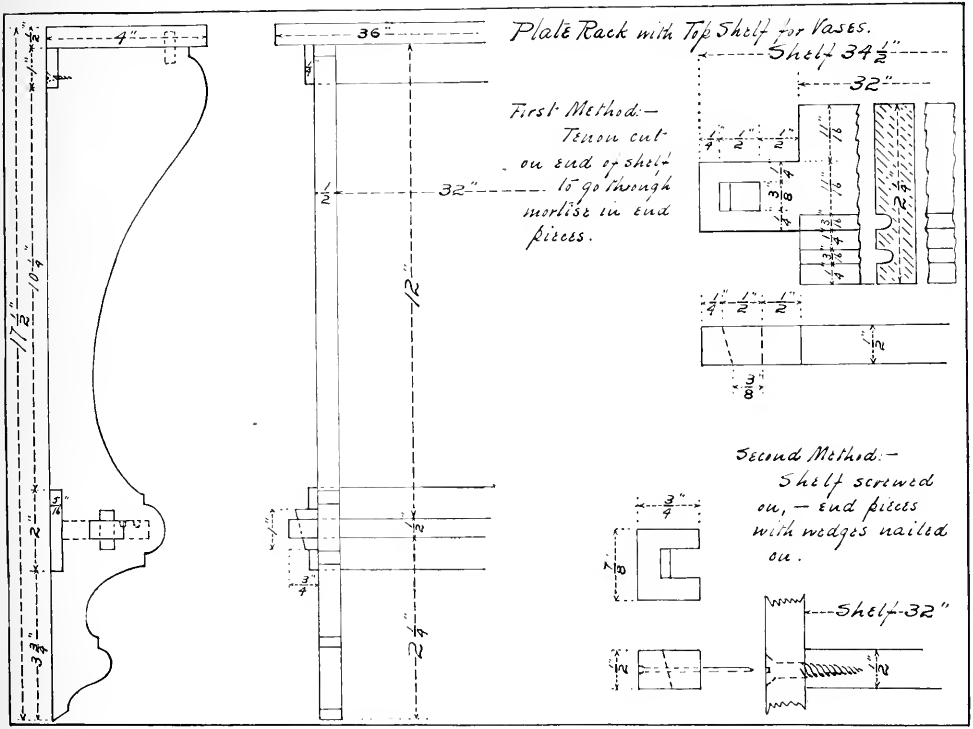


Plate Rack with Top Shelf for Vases.
Shelf 34 1/2"
32"
36"
4"
First Method:—
Tenon cut on end of shelf to go through mortise in end pieces.
32"
12"
17 1/2"
10 1/4"
2"
3 3/4"
2 1/4"
Second Method:—
Shelf screwed on,—end pieces with wedges nailed on.
Shelf 32"

FIG. 262

Stock Bill

2 P—21"x$3\frac{1}{4}$"x$\frac{3}{4}$"—end pieces.
1 P—35"x2"x$\frac{1}{2}$"—upper shelf.
1 P—35"x$2\frac{1}{2}$"x$\frac{1}{2}$"—lower shelf.
2 P—34"x2"x$\frac{5}{16}$"—back strips.
4 P—1"x$\frac{3}{8}$"x$\frac{1}{2}$"—wedges.

The back strips are gained in, or let in, their full thickness, into the back edge of the end pieces and are to project $\frac{1}{4}$ in. at either end. These strips are screwed to the end pieces and may be screwed to the shelves also.

The shelves may be tenoned and driven through mortises in end pieces, or they may be cut off the exact length—32 in.—between end pieces, and screwed on with flat-headed screws through the end pieces. The projecting pieces and wedges are made separately, and nailed on.

Shelves are to be grooved along front edge to hold plates securely.

Stain or fill the desired color, and wax or varnish, following directions under Finishing.

Small hooks are screwed into the under side of lower shelf, from which teacups are suspended.

To fasten to wall, screw into the back edge of end pieces, at the top, two thin brass plates, containing three holes for screws.

PLATE RACK—OLD MISSION STYLE

A rack to hold three medium-sized plates will require 32 ins. between end pieces (Fig. 264).

Stock Bill

2 P—$16\frac{3}{4}$"x$4\frac{1}{4}$"x$\frac{3}{4}$"—end pieces.
1 P—35"x$3\frac{1}{2}$"x$\frac{1}{2}$"—upper shelf.
1 P—35"x$2\frac{1}{2}$"x$\frac{1}{2}$"—lower shelf.
2 P—34"x2"x$\frac{5}{16}$"—back strips.
6 P—1"x$\frac{1}{2}$"x$\frac{3}{8}$"—wedges.

The back strips are gained in, or let in, their full thickness into the back edge of the end pieces and are to project $\frac{1}{4}$ in. at either end. These strips are screwed to the end pieces and back edges of shelves.

The shelves may be tenoned and driven through mortises in end pieces and wedged, or they may be cut off the exact length—32 ins.—between end pieces, and screwed on with flat-headed screws through the end pieces. The projecting pieces and wedges are made separately and nailed on.

The upper shelf is to be grooved along the back edge, and the lower shelf along the front edge to hold plates securely.

Stain or fill the desired color, and wax or varnish, following directions under Finishing.

Small hooks are screwed into the under side of shelves, from which teacups are suspended.

To fasten to wall, screw into back edge of end pieces, at the top, two thin brass plates containing three holes for screws.

Note.—Plate racks are made with narrower shelves, that the plates may lean forward against a small rail or stick, between the two end pieces. In these racks the plates lean against the wall.

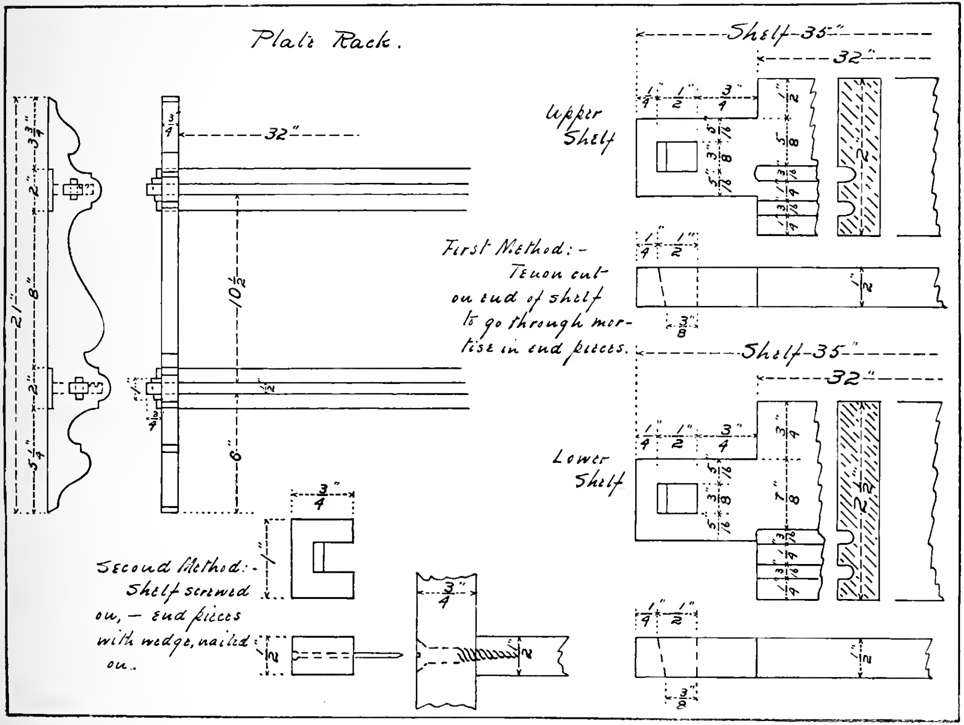


Plate Rack.
Upper Shelf
Shelf-35"
32"
First Method:- Tenon cut on end of shelf to go through mortise in end pieces.
Lower Shelf
Second Method:- Shelf screwed on, — end pieces with wedge, nailed on.
21"
10½
6"

FIG. 263

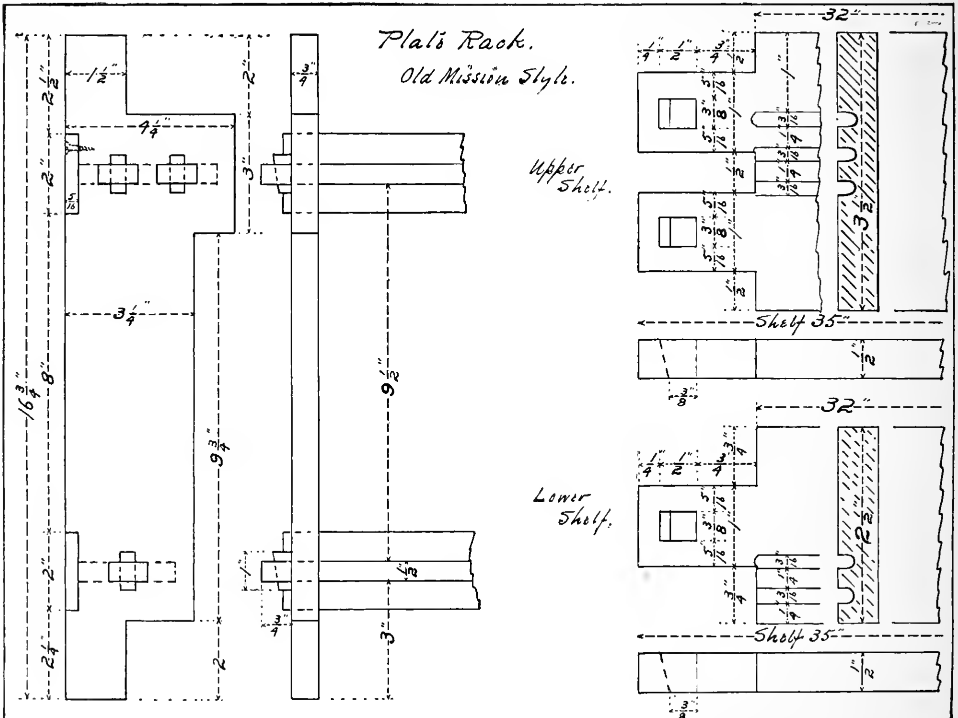


Plate Rack.
Old Mission Style.
Upper Shelf.
Lower Shelf.
Shelf 35"
32"

Fig. 264

SEWING TABLE

(Only 28 ins. high)

With shelf and drawer—legs screwed on, drawer opens from either side (Fig. 265).

This table may be made regular table height, 30 ins., and used for a reading table, or may be made larger for a library table, with top 32 ins. x 22 ins., or 36 ins. x 24 ins., in which case the shelf may be 7 ins. down from top, and the drawer widened to 12 ins. or 14 ins. The legs of the larger table must be made thicker also; 2 ins. wide by 1¼ ins. thick.

The lower shelf may be cut away 2 ins. at front and back to admit of sitting closer to table (Fig. 266).

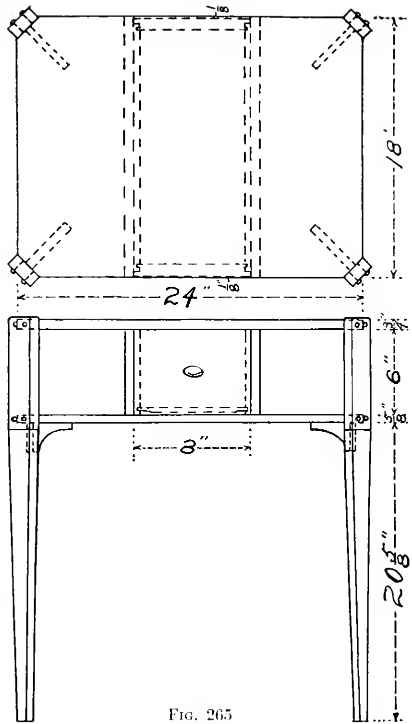


Fig. 265

Stock Bill

1 P—24"x18"x$\frac{3}{4}$"—top.
1 P—24"x18"x$\frac{5}{8}$"—shelf.
2 P—6"x18"x$\frac{5}{8}$"—partitions at end of drawer.
2 P—8"x6"x$\frac{3}{4}$"—drawer fronts.
2 P—17$\frac{1}{4}$"x6"x$\frac{3}{8}$"—drawer sides.
1 P—7$\frac{5}{8}$"x16$\frac{1}{4}$"x$\frac{5}{16}$"—drawer bottom.
4 P—28$\frac{1}{4}$"x2x$\frac{7}{8}$"—legs.
2 P—5$\frac{1}{2}$"x2"x$\frac{3}{4}$"—to make corner braces.

Construction

Glue up top of table, shelf, partitions at end of drawer, plane off faces, and let dry as long as possible, to shrink.

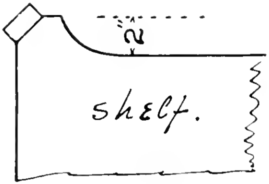


Fig. 266

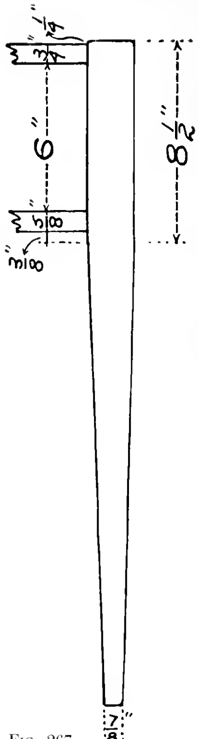


Fig. 267

Legs

Plane up legs to dimensions, beginning to taper, in width only, $8\frac{1}{2}$ ins. from top end, tapering to $\frac{7}{8}$ in. wide at foot. Round over the corners at top end $\frac{3}{16}$ in. (Fig. 267).

Drawer

Make drawer fronts $8\frac{1}{16}$ ins. long, and $6\frac{1}{8}$ ins. wide, to allow for fitting—drawer sides also $6\frac{1}{8}$ ins. wide. Drawer sides may be grooved into fronts, or may be dovetailed into fronts.

If grooved in, make deep groove in ends of drawer front, $\frac{3}{8}$ in. deep (the thickness of the sides), and $\frac{1}{8}$ in. in from inside face of drawer front (Fig. 268).

Saw away the thin tongue, leaving it only $\frac{1}{8}$ in. long.

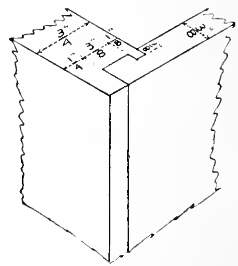


Fig. 268

Groove the drawer side $\frac{1}{8}$ in. deep, and $\frac{1}{8}$ in. wide, to receive the short tongue (Fig. 269).

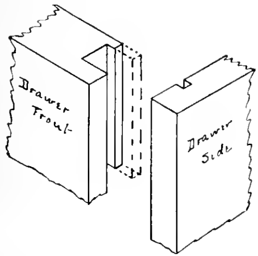


FIG. 269

Groove the fronts and sides of the drawer $\frac{3}{8}$ in. up from lower edge, to receive drawer bottom, gauging and chiseling out groove, or planing it with grooving plane (Fig. 270).

Bevel off drawer bottom on under side, to make edge wedge-shaped, to fit groove perfectly on upper side.

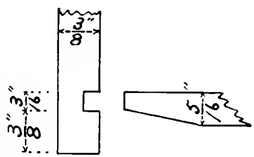


FIG. 270

Dovetailing

In making dovetailed drawers, the front of the drawer is finished first—laid out, sawed, and chiseled. The finished end of drawer front is then held down tightly on the drawer side, and the side marked out with a knife from the completed front. It would be impossible to make a well-fitting dovetailed joint in any other way.

In hand-made dovetails, the tenons are very small or narrow, and the mortises wide (Fig. 271), to distinguish the hand-made from the machine-made dovetails, in which the mortises and tenons are always equal in width (Fig. 272).

Gauging

Gauge on end of drawer front the distance the drawer side is to lap over drawer front; in this case $\frac{1}{2}$ in. With same set of gauge, gauge across the end of drawer sides, on both faces of sides. Set gauge to thickness of drawer sides, $\frac{3}{8}$ in., and gauge across inside face of drawer front, to show depth of mortises in drawer front.

To Lay Out Dovetails

Locate the groove for drawer bottom, and cover this groove with first tail. Use your judgment in regard to slant or flare of tail. If too much flare is given the long corners of the tails in the drawer sides break away (Fig. 273). Experience has shown that $\frac{1}{8}$ in. flare on each side of tail is sufficient, if tail is $\frac{1}{2}$ in. long (Fig. 274).

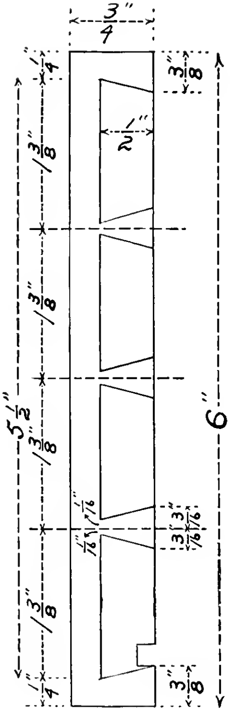


FIG. 271

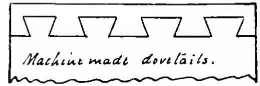


FIG. 272

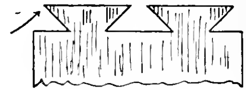


FIG. 273

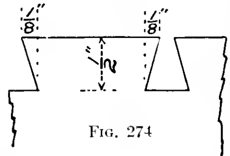


FIG. 274

Do not waste time figuring out widths of tenons or tails, but after laying out first flare or slant over groove for drawer bottom, and its opposite on other edge of drawer front, divide the remaining distance into equal parts, for center lines for tenons; in this case, $5\frac{1}{2}$ ins. into 4 parts. Use judgment in deciding on width of centers for tenons; too many tails make too much work.

Draw center lines through these divisions, lay off $\frac{1}{16}$ in. on either side for narrow edge of tenons and $\frac{3}{16}$ in. on either side for wide edge of tenons—the tenons are the triangular shaped parts of the drawer front, left after cutting out mortises for tails (Fig. 275). The $\frac{1}{8}$ in. width for narrow edge of tenon is more than is generally

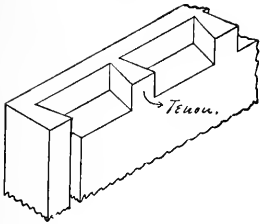


FIG. 275

given for fine, hand-made dovetails; the usual width is a narrow saw kerf only, about $\frac{1}{16}$ in.

With bevel set to required angle, and a sharp knife, knife the mortises. With try-square and knife, knife the gauge lines.

Saw, with fine tenon saw, exactly to knife lines, sawing kerf out of mortises; not out of tenons (Fig. 276).

Chisel out mortises in ends of front to knife lines (Fig. 277).

Hold drawer front straight up on drawer side, with inside face of front just touching gauged line $\frac{1}{2}$ in. from end of drawer side. Mark out, with sharp knife, the shape of completed mortises (Fig. 278).

With fine tenon saw, saw exactly to knife lines; saw away also the triangular pieces at sides. Chisel out triangular mortises for tenons, chiseling from both sides of the board (Fig. 279).

Fit drawer bottom, and drive drawer together, dry, without glue.

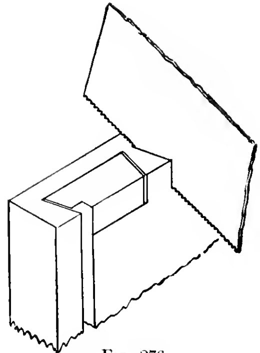


FIG. 276

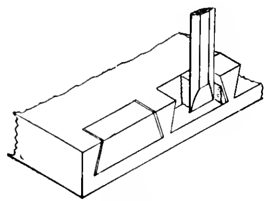


FIG. 277

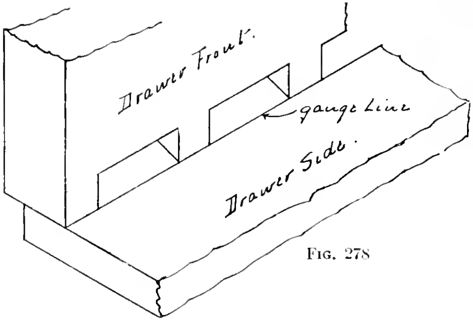


FIG. 278

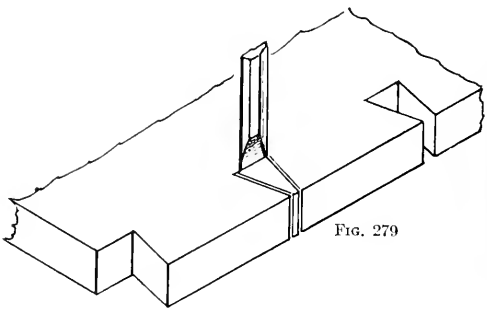


FIG. 279

Warm wood in warming oven, and glue together, driving dovetails together with hammer. Do not glue drawer bottom in at any place.

Square up drawer with large try-square, and let dry over night.

Top and Shelf

Plane partitions to exact dimensions, lay out exact position on top and shelf; drive in small brads to mark dowel hole centers, bore for $\frac{3}{8}$ in. dowels, taking care not to let point of bit come through top side of top. Fit partitions in place dry, and screw up dry, with hand screws.

Take apart, lay out corners of top, making diagonal corners exactly 2 ins. long, or as long as width of legs, saw off corners, and plane true.

Lay top of lathe on shelf and mark out shelf from top, taking great care to have shelf exact size of top, or legs will stand awry.

Warm partition in warming oven slightly, and glue partitions, top and shelf together.

Screw legs in place, using $2\frac{1}{2}$ in. or 3 in. No. 14 round head, blued screws.

Prepare small blocks for braces (Fig. 280), and glue and screw braces to lower shelf; do not glue braces to legs.

Screw braces to legs carefully; the braces will stiffen legs very much.

Carefully fit drawer, that it may run in and out smoothly, without binding or rattling.

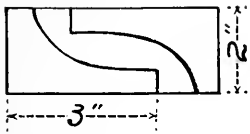


Fig. 280

Fit a lock to drawer if desired.

A spring button, similar to a glove button, may be fitted to under edge of drawer front, to stop it in right place.

Stain or fill, following directions under Finishing.

The inside of drawer will look better if sandpapered smooth and white, and varnished natural, with shellac or copal.

In tables and chests of drawers which stand against the wall, and in which the drawer has only one front—does not open from either side—the drawer back is made $\frac{3}{8}$ in. thick, and wide enough only to extend down to groove for drawer bottom, allowing the drawer bottom to slide in and out.

The tenons in the drawer back are marked out and sawed clear through and through the board, then the back is held upon the drawer sides, and the shape of the mortises marked out, with a sharp knife, on the sides, as before.

SMALL TABLE

(Combination Turning and Cabinet Exercise)

(Fig. 281)

Stock Bill

1 P—$17\frac{1}{2}''$x$13\frac{1}{2}''$x$\frac{3}{4}''$—top.
2 P—$14''$x$4''$x$\frac{7}{8}''$—side rails.
2 P—$9\frac{1}{2}''$x$4''$x$\frac{7}{8}''$—end rails.
2 P—$13\frac{1}{2}''$x$\frac{1}{2}''$x$\frac{1}{8}''$—molding.
2 P—$9\frac{1}{2}''$x$\frac{1}{2}''$x$\frac{1}{8}''$—molding.
4 P—$12''$x$2\frac{3}{4}''$x$2''$—legs.

The legs may be sawed to shape indicated (Fig. 283), and then turned.

After turning, saw at band saw to dimensions shown at toe (Fig. 282), hollow out two soft pine blocks to prevent vise from bruising upper part of leg, screw in vise, and spoke-shave leg round and true.

Sandpaper toe until ridges left by spoke-shave are smoothed off.

From the flat molding, $\frac{1}{2}$ in. wide, to the top of the leg, one-quarter of the leg is to be sawed and chiseled away, to receive the square corner of the box or rails (Fig. 285).

Lay out this quarter opposite the toe of the leg, with knife and square end of try-square blade.

Prepare templet, or block of wood about $2\frac{5}{8}$ ins. long, and $1\frac{1}{8}$ x $1\frac{1}{8}$ ins. wide and thick.

Since the body of leg is $1\frac{1}{2}$ ins. in diameter, to mark off this part of leg, gauge $\frac{3}{4}$ in. along two adjacent sides of templet block, saw out or chisel out the corner (Fig.

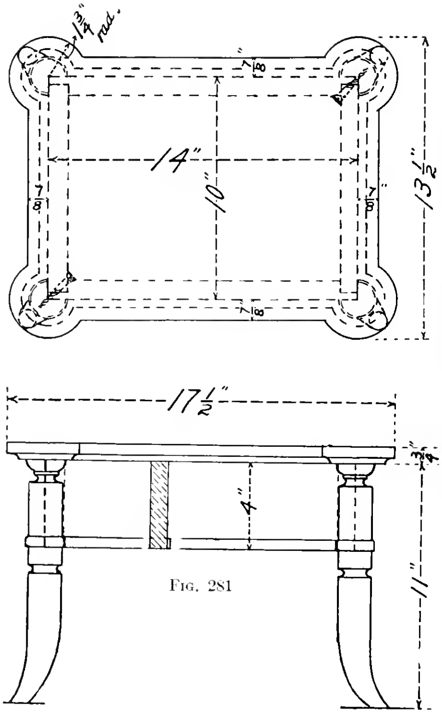


FIG. 281

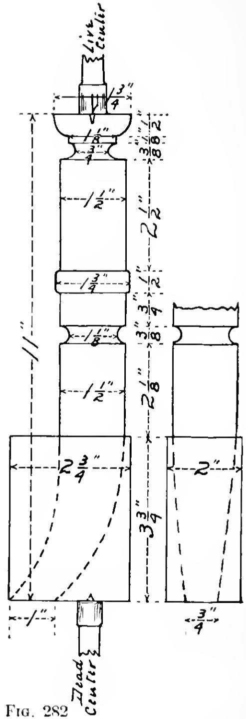


FIG. 282

286), and use the edges A and B as straight edges to mark out cylinder with knife (Fig. 287).

Saw with tenon saw, outside and close to knife lines, chisel corner out square, trying with try-square, and number and fit each leg to its corner when rails are glued up and squared.

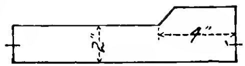
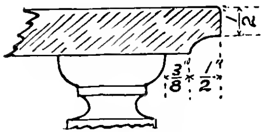


Fig. 283



Projection of Top
Fig. 284

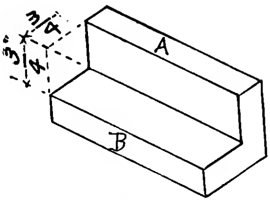


Fig. 286

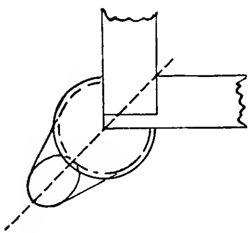


Fig. 285

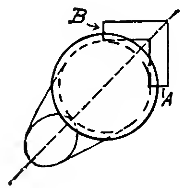


Fig. 287

Rails

Plane outside faces of side and end rails true and smooth.

Cut out of side rails a square rabbet or gain, at ends, in depth the thickness of the end rails, and up to $\frac{1}{4}$ in. of face of side rails, so that joint will be covered by leg (Fig. 288).

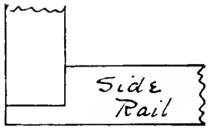


FIG. 288

Carefully glue and nail rails together at corners, taking care that no nail hole shows $\frac{7}{8}$ in. down from top edge of rails, as at that distance down the leg is only $\frac{3}{4}$ in. in diameter.

Square up box or rails with try-square, when glued and nailed, and lay aside to dry for two hours.

When dry, plane corners true and smooth, and sandpaper outside faces of rails. Joint the lower edges of rails also.

With rails held in vise, bore for screws with $\frac{7}{32}$ in. gimlet bit, slanting the holes slightly toward the upper and lower edge, that the screw-driver may be held outside the box (Fig. 289).

Prepare a short corner block, A, and a shaped block, B, to fit outside of curved leg (Fig. 290). These blocks

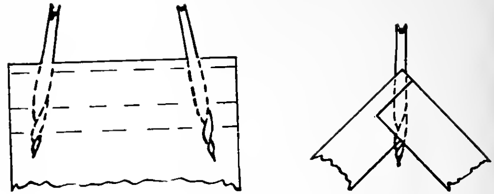


FIG. 289

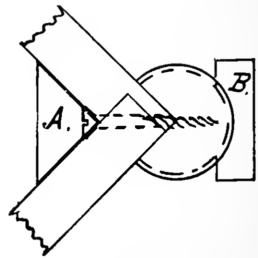


FIG. 290

are to receive the hand screw that holds the leg in place while screwing it on.

Warm leg in warming oven, glue carefully with hot glue, and screw in place, using $1\frac{3}{4}$ in. or 2 in. No. 11 screws.

Miter the $\frac{1}{2}$ x $\frac{1}{8}$ in. molding to molding on leg, making a perfectly fitted miter joint. Warm moldings

in warming oven and glue to rails. Joint off upper edge of rails, including top end of legs.

Bore large slanting hole about $\frac{3}{4}$ in. down from top edge of rail, to form a shoulder for screw head, and bore $\frac{7}{32}$ in. or $\frac{1}{4}$ in. holes for screws (Fig. 291).

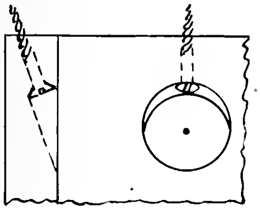


Fig. 291

Top

Carefully lay out top to dimensions shown (Fig. 281) and saw at band saw. Spoke-shave and file edges smooth and true to exact shape.

Mark off molding on lower face and on edge, and with carving gouge gouge out molding, making careful miters at intersection of curves with straight sides.

Hold top in place with hand screws and screw on top.

Saw off any long leg, at lower end, with tenon saw, and bevel off all legs at toe to prevent splitting off.

Fill and wax, following directions under Finishing.

SUGGESTIVE QUESTIONS

Cabinet Making

1. What is meant by cabinet making?
2. Name several hard woods used by cabinet makers.
3. Why do cabinet makers prefer curly, cross grained wood?
4. Instead of nailing, what method is used in cabinet making to hold pieces of wood together?
5. How are the pieces held in place while drying?
6. Show how to use a hand screw, and explain why jaws must be parallel.
7. What convenient clamp takes the place of very large hand screws?
   Make a sketch of the clamp.
8. Make a drawing of a simple, cheap clamp, to glue up table tops—a clamp that may be made and used at home.
9. Name two ways in which two or more boards may be jointed together, and give an argument in favor of each method.
10. Is a board as strong when glued up of several pieces, using glue alone, as it is when doweled, or tongued and grooved, and glued?
11. What is the object of so much pressure in making a good glued joint?
12. Before gluing ends together, how should the wood be treated?
13. What is a rubbed glue joint?
14. What is glue? How do you prepare it?

15. What is the object of heating the wood before gluing?
16. Explain why the plane-bit must be ground truer and straighter and sharpened to a keener edge to use on hard, curly wood.
How must the cover or breaker be set?
17. What tool must be used to finish smoothing a very curly, cross grained piece of wood, after planing?
18. Explain carefully how this tool is sharpened.

Sandpaper

19. Why are fine workmen afraid to use much sandpaper?
20. What makes the best sandpaper block?
21. How is sandpaper made?
22. How is it marked as regards fineness and coarseness?

Varnishing

23. What oil is sometimes used before varnishing woodwork to enrich the grain? What proportion of turpentine must be used with it?
24. What spirit varnish is recommended by varnish firms to be used before varnishing with copal?
How does this varnish hold the natural color of the wood?
25. What is wood-filler, and why is it used?
26. Explain carefully how it is brushed on and cleaned off.
27. What color of filler must be used for natural wood, mahogany or red oak, Flemish oak, antique or weathered oak?

Stains

28. What can you say of the use of stains in preparing for finishing woods?
29. Name three kinds of stains.
30. Why is the oil stain better than water stain?
31. What two stains combined give mahogany and cherry the rich, old color so much desired?
32. Explain carefully the method of using these solutions.

To Stain Oak

33. Why does oak require more filler than other woods?
34. How apply the golden oak stain before filling?
Do the stains color the lights? Why?
35. How are the rays or lights in quartered oak made to show more brightly?

Varnish

36. What is shellac varnish?
37. State fully how lac is formed; how it is reduced to stick-lac and shell-lac; bleached white; unbleached; orange.
38. In purifying shellac, what coloring matter is obtained from the bodies of the little insects?
Is this coloring matter costly?
39. How do you apply shellac, and must it be brushed on thick or thin?

40. How long should each coat dry?
Why wet the sandpaper to sandpaper varnish?
Should a block be used to hold the sandpaper?
41. Give two reasons for using shellac varnish before copal.
42. Will shellac varnish stand moisture?
Why is it used on floors and stairways?
What is meant by quick finishing?
43. Besides its use as a preservative of wood, what other uses has shellac?
44. What must be done to shellac varnish and other varnishes, to keep them in good condition?

Copal Varnish

45. What is copal varnish?
46. What is copal gum and where obtained or found?
47. From what is linseed oil obtained?
How is it prepared for varnish?
48. What is turpentine? Explain fully how it is obtained, and at what sacrifice to the tree. What is a still?
49. Explain how the three ingredients are combined to make copal varnish.
50. Name several ways in which varnish "acts up."
51. Where should varnishing be done?
52. Will copal varnish stand moisture, heat, and cold? Why?
53. How do varnish manufacturers insist on thinning the varnish, rather than by pouring into it raw turpentine? Why?

To Flow Copal

54. Explain carefully just how to "flow" copal.
55. How long should each coat of copal dry? State carefully how to prepare one coat for the next.
56. Should a block of wood be used to hold the sandpaper? Why?
57. If dry, how should the varnish come off on the sandpaper?
If not perfectly dry, how does it act?
58. Why brush off after each sandpapering?
59. Why allow a longer time to elapse between the latter coats of copal?
60. Should the last coat be sandpapered? Why?

Rubbing Down

61. Why is it necessary to rub down varnish? Give several good reasons.
62. What is pumice stone? How prepared for use in rubbing down varnish?
63. With what will it cut fast and clean? With what is it sometimes used?
64. Describe very carefully the process of rubbing down.
Why is the felt first held on a block?

Patching

65. What must be done first if the varnish is rubbed through?
66. How get the color to the bare wood after rubbing through?

67. Explain carefully with sketch how to apply the varnish on a patch.
68. Should copal varnish be patched with shellac varnish? Why?

Polishing

69. What makes it necessary to polish?
70. What is rotten stone? With what is it used to polish?
71. Explain carefully how to proceed in polishing a varnished surface.
72. What makes the best rubber with which to polish?

Waxing

73. What do you know of waxed furniture?
74. Why is varnishing a better way of finishing wood?
75. What is our furniture wax?
76. What do the manufacturers of the wax polish insist on, if a smooth, bright surface is required?
77. Describe carefully how the wax is applied, rubbed off, and polished. How many coats are necessary?

Cracking and Blistering

78. What must be done if the varnish cracks between coats?
79. What makes the varnish on old furniture crack?
80. Will varnishing over the old cracked varnish remedy matters?
81. If varnish blisters, what must be done?

METHODS OF MOLDING

A pattern maker should know something of molding, that his patterns may be removed from the sand easily.

A casting is generally made in molding sand, held in place by a "flask," a frame of iron or wood, with neither top nor bottom.

The flask is made in two or more parts: an upper, called the "cope," and the lower, named the "drag"

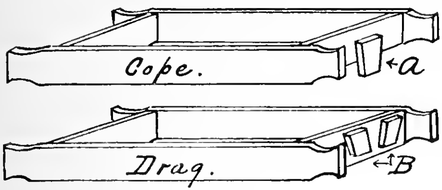


Fig. 292

or "nowel"; the two parts fitting on each other by means of pins and a corresponding way, as at A, B (Fig. 292).

The wooden pattern for the casting may be rammed up wholly in the drag, or partly in the drag and cope.

When rammed up in both parts, the pattern is sometimes made in two parts, so that it will separate on the line separating the two parts of the flask.

This place of separation in the pattern, and also the line of separation between the flasks, is called the "parting" (Fig. 293, *a*).

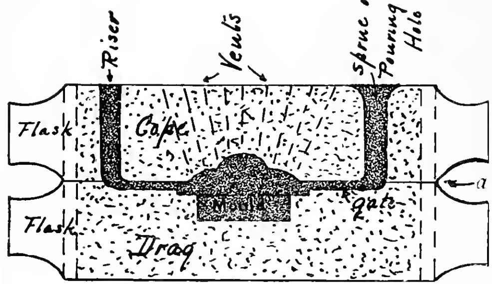


Fig. 293

The line of separation is not always a straight line or plain, as the sand of the cope often hangs down into the drag, on account of some depression or hole in the pattern. In casting a hollow ring, the cope sand is rammed down into the round hole, and lifts out with the cope (Fig. 294).

Sometimes the pattern maker does not take time to "part" his pattern, so a solid pattern for a cylinder

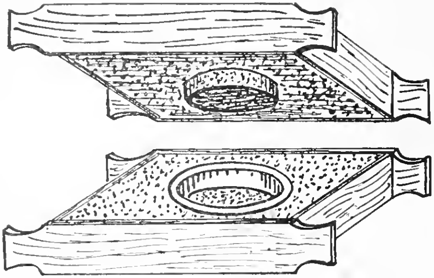


FIG. 294

would be rammed up entirely within the drag (Fig. 295). But to get the pattern out, the sand must be lifted

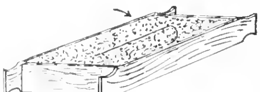


FIG. 295

away (Fig. 296) half way down the pattern. The cope sand is then rammed about the exposed half of the cylinder and lifts off (Fig. 297). This lifting the sand away in the drag (to get the pattern out), to be replaced by sand rammed up in the cope, is called "coping down."

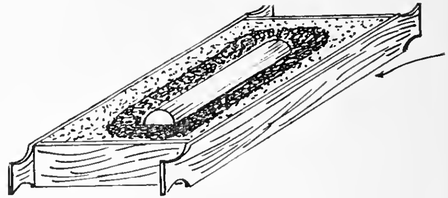


FIG. 296

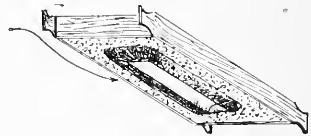


FIG. 297

The pattern for the cylinder should be made in two parts, "parted"; half of it is rammed up in the drag (Fig. 298), the other half, having projecting pins to fit

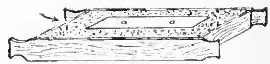


FIG. 298

the holes, is laid on and rammed up in the cope. When the two parts of the flask are lifted apart, the pattern is removed easily.

Coring and Cores

A core is the baked shape or form of the inside opening or chamber of a casting. It is made of coarse sand and flour and oil, and is shaped in a core-box, then baked in a core-oven until very hard. The flour and water form a paste to hold the sand together, and the oil makes the core smooth, and is used, also, that it may take fire and burn up the gases caused by the molten metal pouring into the mold. These gases, together with the steam formed by the hot metal against the moist sand, would "blow up" the mold, unless "vented" freely, and made to burn.

The core-box, in which the core is shaped before baking, must be made to come apart very easily, in order not to spoil the core.

Cylindrical cores—round cores—are always made in half core-boxes (Fig. 299) that the soft half cores (Fig.

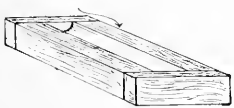


FIG. 299

300) may lie on their flat diameters while baking, instead of on their round outside surfaces. The two

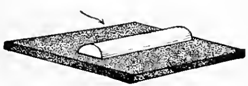


FIG. 300

halves are then glued or pasted together, after filing a groove lengthwise in each, for a vent.

To cast a cylinder with a round hole through it, from end to end (Fig. 301) the pattern would be made the

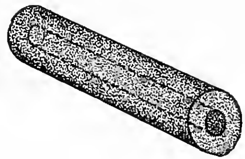


FIG. 301

FIG. 302

length and diameter required, and on both ends would be turned core-prints, having the diameter of the hole, and of reasonable length (Fig. 302). These prints become, then, a part of the pattern, and together with the pattern, will leave a print or impression in the sand. This shape or impression left by the core-prints is to be the resting place of the core, which is made long enough to extend from print to print, over across the impression made by the pattern proper (Fig. 303).

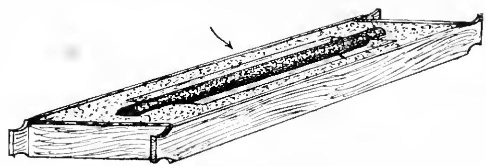


FIG. 303

The metal pours in around the core, filling the impression made by the pattern.

The core fills the impression made by the core prints, so no metal pours into these holes.

When cool, the core is broken up and rammed out of the casting, a new core being required for each casting.

The head-stock has two arms at the back, to hold a shaft, on which are gear wheels. The bearings for this shaft are quite long, and are cored out (Fig. 304).

Will a pattern shaped like the head-stock, with the arms and bearings, pull from the sand?

A careful study of the drawing will show that it is

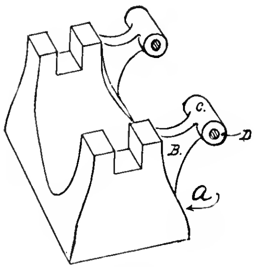


Fig. 304

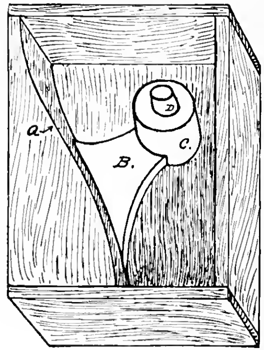


Fig. 305

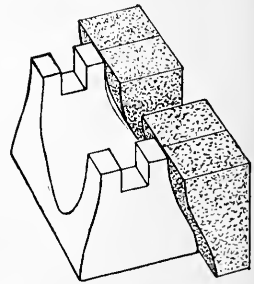


Fig. 306

The metal is frequently poured in core sand or cores, green sand not being used.

The drawing by Peter S. Dingey (Fig. 372), showing how a chain is cast, makes plain the method.

The metal is sometimes poured into molds made from patterns and core-sand molds combined, as in the case of the head-stock of the machine lathe.

impossible to ram such a pattern up in any way and get it out of the sand.

So the part of the pattern that will pull (the head-stock proper, without the arms and bearings), is made of wood as usual.

A core-box is made (Fig. 305) with one edge having the exact curve, *a*, of the pattern, that the core may

fit the pattern perfectly. In the bottom of this core-box is glued a shape of half the thickness of the arm (see B); also half the length of the bearing (see C); also a short core-print, to core the hole through the bearing, is glued on the pattern of the half-bearing (see D).

Another core-box, to make the left half of the arm and the bearing, is made (two core-boxes are necessary, a right and left), also a little core-box, in which to shape the round core for the hole through the bearing.

Two of the large cores, a right and left, are now pasted together, with the little round core hanging in place across the opening inside, which opening is the full size of the arm and bearing. These hollow cores are now placed against the wooden pattern, and whole rammed up together, turned over and the wooden pattern (the head-stock proper) lifted out, leaving the large mold of the wooden pattern and the neck and bearings to be poured full of iron (the cores are, of course, held firmly in place by the green sand rammed up around them) (Fig. 306).

Movable Parts

A pattern would frequently pull from the sand easily if it were not for some little boss, or over-hanging part or extra ring, which interferes with the patterns coming from the sand.

These parts are made separately and fastened to the pattern proper while ramming up, with long, loose nails or dowels, which are pulled out after the pattern is rammed up, then the pattern will slide past the loose boss or over-hanging part, which remains in the sand, to be picked out with a wire or the fingers, after the larger part of the pattern has been removed.

The pattern for the gibbed way, if made like Fig. 307,

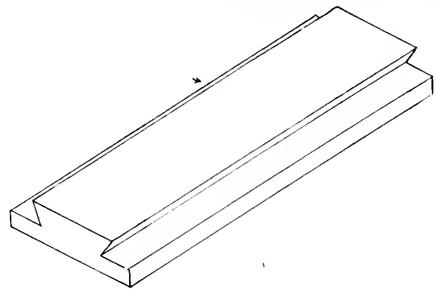


Fig. 307

would not come from the sand, so part of the pattern (Fig. 308) is made to pull as usual, and the over-hanging parts are made separately, and fastened to the

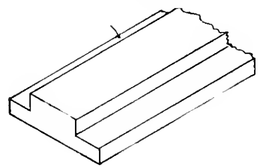


Fig. 308

main pattern, while ramming up, with little dovetailed, wedge-shaped pieces (Fig. 309).

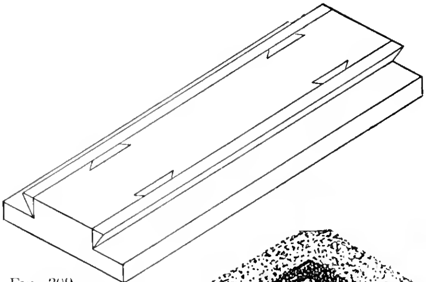


FIG. 309

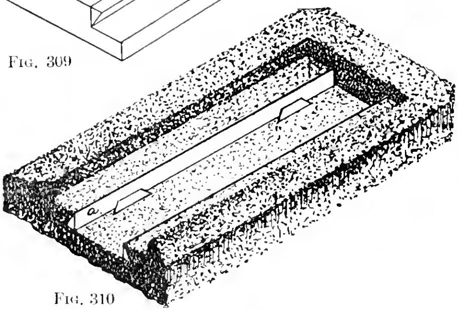


FIG. 310

When the larger part of pattern is removed, these over-hanging, triangular pieces are left in the mold, under the sand (Fig. 310, *a*), and are slid from under with a wire, or the fingers, and lifted out.

Another example is the shifting fork, with the boss on the end, B (Fig. 311), to take the set screw. This boss interferes with the pattern being rammed up on its flat back, and makes it necessary for the molder to ram it up on its side and cope down to the web.

If the boss is loose, the pattern will pull easily, so it is made without the boss, but with a dovetailed way C (Fig. 311) cut in the end. The boss is made on the block to fit the way. The two pieces are put together, the pattern rammed up on its back, and when the larger part is removed, the boss remains in the sand, to be pulled out easily with a wire.

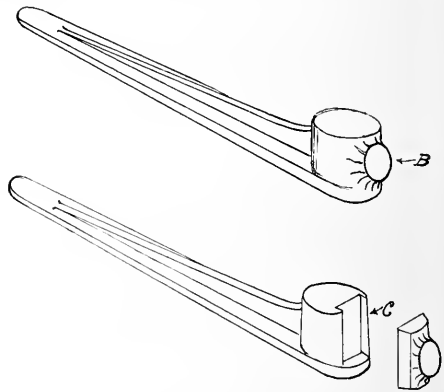


FIG. 311

Another example of the movable boss is that on the pattern for the small, cast-iron turbine case. An elevation plan, also a section through A, B, are shown (Fig. 312).

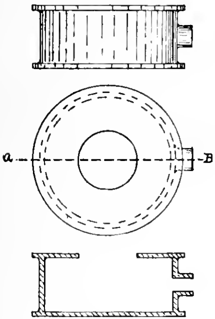


Fig. 312

Note.—Drawings show a section of pattern in the sand.

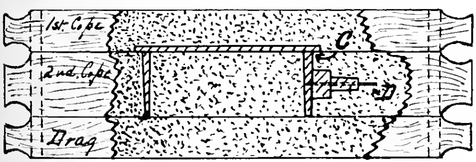


Fig. 313

The top disk, having the large hole, is cast separately, and screwed to the case.

The lower disk and the case are parted at C, and together are rammed up in a 3-parted flask (Fig. 313).

The boss will prevent the main part of the pattern from being removed from the sand, so it is made loose and fastened, with its long core-print, to the pattern with a loose dowel, which is pulled out after the pattern is rammed up, the boss being held firmly against the pattern by the green sand (see D).

The first cope (Fig. 314) is first taken off, and the flat disk (Fig. 315) removed.

Fig. 314

Fig. 315

The hollow case (Fig. 316) is next removed from the second cope, leaving the boss (Fig. 317).

Then the second cope is lifted off, taking with it the boss.

Fig. 316

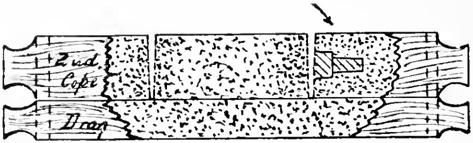


Fig. 317

The boss is now easily removed (Fig. 318). The pattern leaves its own core—the green sand core resting on the drag (Fig. 319).

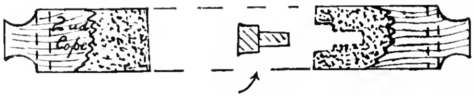


Fig. 318

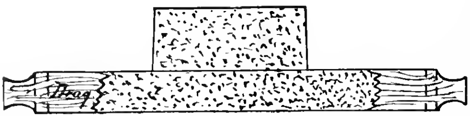


Fig. 319

This pattern could be rammed up in a two-parted flask (Fig. 320) if a solid core-print, extending the whole width of the case, were glued on (see *a*, *a*, Fig. 321).

In the impression made by this print is slid a core, made in the core-box *b*, *b*.

The inside of the bottom of this box is curved to

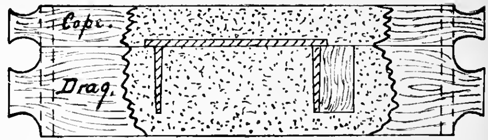


Fig. 320

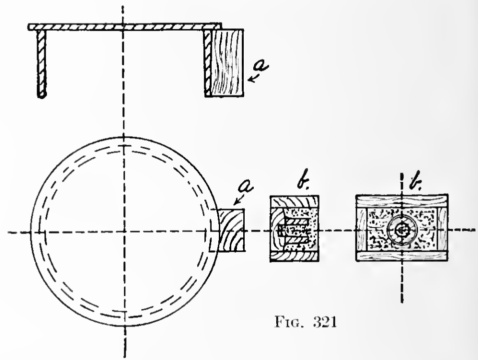


Fig. 321

correspond to the curvature of the case. On the bottom is glued a boss, the exact size and shape of the boss on the drawing shown.

Notice that the hole in the boss is continued down into the bottom board of the core-box, that the core made may core a hole through the case also.

This core, in connection with the pattern, will form a mold which will give the casting required.

Metal Patterns

If many castings are to be made from the same pattern, the pattern is made of metal. These metal patterns are very serviceable, and leave the sand more easily and cleanly than those made of wood. Metal patterns are always used when the castings are of a delicate or light character. In all such cases, the first pattern, from which the metal pattern is to be molded, is made of wood, allowance being made for double shrinkage.

SUGGESTIVE QUESTIONS

Methods of Molding

1. Why should a pattern maker know something of molding?
2. In what is a casting generally made?
3. What is a molding flask, and name the parts?
4. May the pattern be rammed up in either part? Explain.
5. Why are patterns made in two or more parts? Explain.
6. What is meant by the parting? Is the parting line always a plane or a straight line?
7. Make a sketch showing the two parts of a flask, the pattern rammed up in place, the sprue, the gate, the riser, vents, and name each part.
8. Make a sketch showing how a solid pattern of a cylinder may be rammed up and removed.
9. What is meant by coping down?

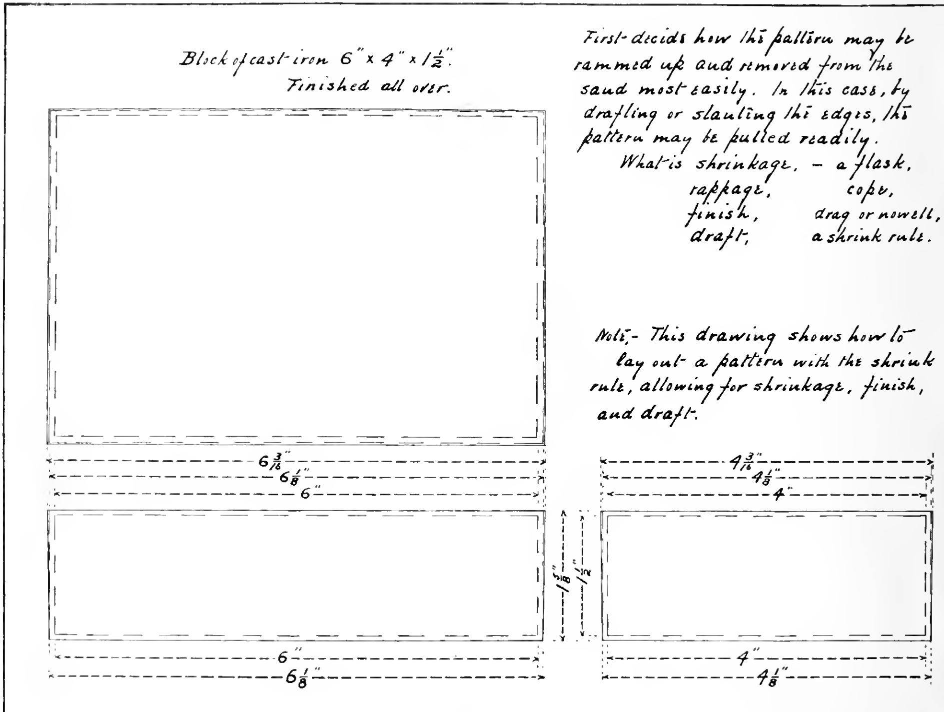
Coring and Cores

10. What is a core, and of what is it made?
11. What is a core-box, and how must it be constructed?
12. How are cylindrical cores always made?
13. What are core-prints?
14. Make a sketch of a pattern for a cylinder 6 ins. long and 2 ins. in diameter, having a straight hole through it, from end to end, 1 in. in diameter.
15. What becomes of the cores after a casting is made?
16. Is the metal always poured in molding sand? Explain.
17. Describe carefully the method of preparing the mold for the head-stock of the machine lathe.
18. Why is it necessary to make patterns with movable parts?

    How are these parts held in place while ramming up?
19. Describe two or three patterns which must be made with movable parts, if they are to be taken from the sand easily.
20. What is a three-parted flask? Name its parts.
21. Show why it is necessary to have a three-parted flask in which to ram up the turbine case.
22. Why have such a long core-print on the boss?
23. Describe another method of ramming up the turbine case in a regular flask.

Metal Patterns

24. Explain carefully why metal patterns are used.
25. What is double shrinkage?



Block of cast iron 6" x 4" x 1½".
Finished all over.
First decide how the pattern may be rammed up and removed from the sand most easily. In this case, by drafting or slanting the edges, the pattern may be pulled readily.
What is shrinkage, – a flask,
rappage, cope,
finish, drag or nowell,
draft, a shrink rule.
Note:- This drawing shows how to lay out a pattern with the shrink rule, allowing for shrinkage, finish, and draft.
6 3/16"
6 1/8"
6"
4 3/16"
4 1/8"
4"
1 5/8"
1 1/2"
6"
6 1/8"
4"
4 1/8"

Fig. 322

PATTERN MAKING

Pattern for Iron Block (Fig. 322)

A pattern for a block of iron, introducing finish, shrinkage, draft, rappage. To be varnished black, all over.

The "mold" is the shape in the sand left by the pattern; a good mold is made only by "ramming up" (pounding) the sand hard against the pattern.

To get the pattern out of the sand easily, the mold is divided into two or more parts, called the "cope" and the "nowel" or "drag." The patterns are also divided into two or more parts, to be more readily taken from the mold.

The place where the mold is divided, and the place where the pattern is divided, is called the "parting."

The pattern is also slanted or "drafted" on the vertical edges (made wedge-shaped) so it may be "pulled" or lifted out of the sand easily.

To loosen the sand around the pattern the pattern is rapped or pounded, slightly, sidewise, called "rapping."

FINISH.—Finish, in pattern work, is the extra amount of wood, usually $\frac{1}{16}$ in. or more, added to a pattern on any surface, so that the casting made may be smoothed and trued up on that surface.

SHRINKAGE.—In metal, shrinkage is the amount of contracting or shrinking, while cooling. In pattern work, shrinkage is the amount of wood added to a pattern to allow for the shrinking of the metal while cooling.

In iron this shrinkage averages $\frac{1}{8}$ in. to each 1 ft.

In brass and bronze this shrinkage averages $\frac{3}{16}$ in. to each 1 ft.

SHRINK RULE.—This shrinkage is accurately measured by the shrink rule, which is for iron $\frac{1}{8}$ in. longer than the common rule, or $12\frac{1}{8}$ ins. long, and for brass $\frac{3}{16}$ in. longer or $12\frac{3}{16}$ ins. long to each 1 ft. measurement of the common rule.

Patterns must be made by, and measured with, the shrink rule.

DRAFT.—Draft is the amount of slant or bevel on the vertical face of a pattern, which amount must be added to the dimensions of the pattern.

RAPPAGE.—Rappage is the amount added to the dimensions of the mold by rapping the pattern sidewise in order to loosen it from the sand. Rappage is never considered, excepting in very small patterns.

A thick piece of wire, with a thread or screw at the end, is screwed right into the pattern, and tapped sidewise to loosen the pattern from the sand. In large patterns a rapping plate of metal is let into the pattern and screwed down. This plate has a hole in it, tapped to receive a rod, which is rapped sidewise.

The plate and rod also become the lifting plate and rod, by means of which the heavy pattern is lifted from the sand.

NOTE.—Pupils are to be given the dimensions and drawing of the finished casting only, and are to prepare in each exercise in pattern work their own dimensions and drawings for the pattern. These dimensions and drawings are to be made in their shop books, and are to receive their instructor's signature before beginning work on the pattern.

Varnishing Patterns

Patterns are usually varnished with shellac varnish, because it dries quickly, leaving a very hard, smooth surface. The smooth surface of the pattern makes a smoother mold, and also allows the pattern to be pulled from the sand more easily.

Varnishing is necessary to preserve the pattern, as the damp sand would soon destroy the glue joints, and the usefulness of the pattern, as it would warp out of shape, because of the moisture.

To protect the pattern further, lamp-black is mixed with the varnish (lamp-black is the fine, greasy soot obtained from smoke). The lamp-black adds to the preserving qualities of the varnish, by filling up all the pores of the wood.

It is the general custom to varnish patterns black, if they are to be cast in iron. Core-prints are varnished with the uncolored or natural varnish, or with red varnish, to distinguish them from the pattern. Red varnish is made by mixing shellac varnish with Chinese vermilion.

Patterns made for brass castings are usually painted red, with core-prints some other color—natural or black.

Comparative Weight of Patterns and Castings

Dry white pine, for pattern work, is about one sixteenth ($\frac{1}{16}$) the weight of cast-iron, so the weight of an iron casting may be roughly estimated by multiplying the weight of the pattern by 16.

Fillets

Fillets are small quarter curves (Fig. 323), of any length, used to fill the corners of a pattern (Fig. 324).

FIG. 323

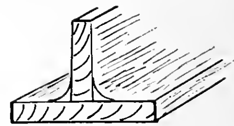


FIG. 324

This filling the corners adds greatly to the strength of the casting, as can be seen, but the real reason that fillets are used is that the little particles of iron, in cooling, arrange themselves around a curve, but separate and divide at a corner, thereby weakening such a casting.

There are wooden fillets, which can be used only on straight patterns, and leather fillets, which can be glued in any corner or curve. These fillets can be bought by the foot, from $\frac{1}{8}$ in. up in width, by sixteenths.

To prepare a leather fillet, lay on a board to apply the glue easily, which must not be too hot, or it will crinkle the leather. Lay in the angle, and rub into position by means of a dowel rod, rounded off at the end to give the required curve to the soft, pliable leather. As soon as the fillet is rubbed into position, wipe off all glue immediately, with a cloth dipped in hot water, and wrung nearly dry.

A cheaper and more common fillet is beeswax, which is pressed into the corners by means of a gouge, heated in warm water.

Shifting Fork with Movable Boss (Fig. 325)

This pattern, with the movable boss, may be rammed up on its flat back in the drag. Without the boss movable it would have to be rammed up on its side and coped down to the web.

Use fillets in the corners at the base of the web, and around the base of the large boss, that there will be no sharp corners of sand, over which the heavy melted iron must flow, carrying with it particles of sand to the bottom of the mold.

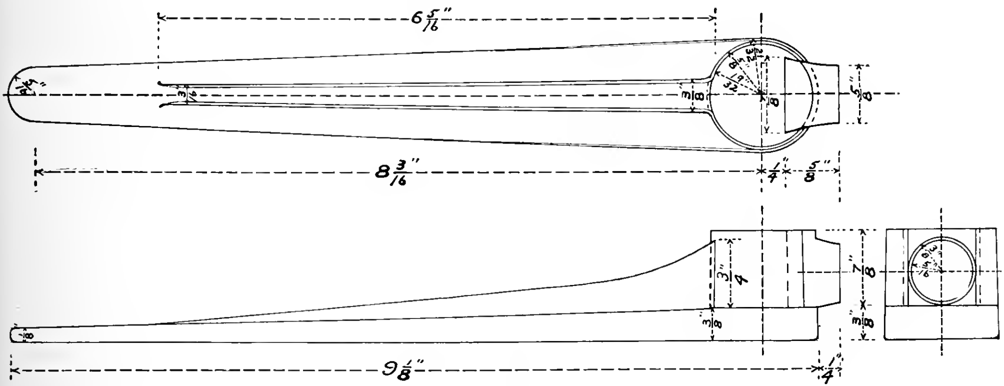


FIG. 325

If the boss (the extra round bit of metal, cast on the end of the fork and tapped for the set screw) were tight, the pattern would have to be rammed up on its side, and the sand lifted away carefully, half way down the pattern, as shown in Figure 326, to get the pattern out.

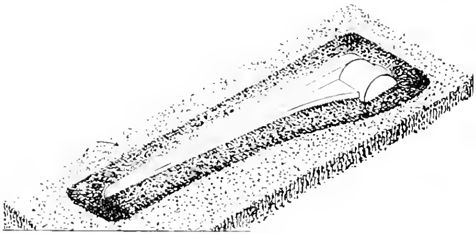


Fig. 326

This makes extra work for the molder, every time the pattern is rammed up. The upper part of the flask—the cope—is then put on, parting sand sifted into the shallow hole around the pattern, and all over the flat surface of the drag, then the cope is rammed up. When lifted off and turned over, the cope has, protruding from it, the shape of the shallow hole around the pattern, in which is the shape of the upper half of the pattern. This cutting down into the drag, and ramming up in the cope, is called "coping down."

If the boss is made loose, making the mold is much simpler The pattern is rammed up on its flat back, turned over, and lifted out of the sand carefully, leaving the boss, partly covered with sand, in the mold. With a sharp wire, the boss is pulled from under the sand, out into the large hole left by the round part of the pattern, and then out of the mold.

A little extra work on the pattern, making the boss loose, saves much extra labor "coping down" every time the pattern is rammed up.

Varnish black, all over, with only one coat inside movable part, that it may not stick.

Pattern for Gibbed Way (Figs. 327, 328)

(With movable parts)

First, decide how a pattern for such a way may be rammed up and pulled from the sand.

It cannot be rammed up on end, because such a way is sometimes 18 ins. or more long.

It may be rammed up on one of its faces, which makes it necessary to have the overhanging parts of the pattern loose, or it will not come from the sand.

If the pattern is drafted toward (made smaller) the flat side, the cope sand will have to be rammed into the dovetailed way, and when lifted off will have to lift out, and drag up, the loose, triangular sticks, which would be poor policy.

If the draft is toward the dovetailed side or face, the loose, triangular sticks will lie in the bottom of the mold, in the drag; the pattern will be lifted up past them, then the sticks may be slid from under the overhanging sand and lifted out (Fig. 329).

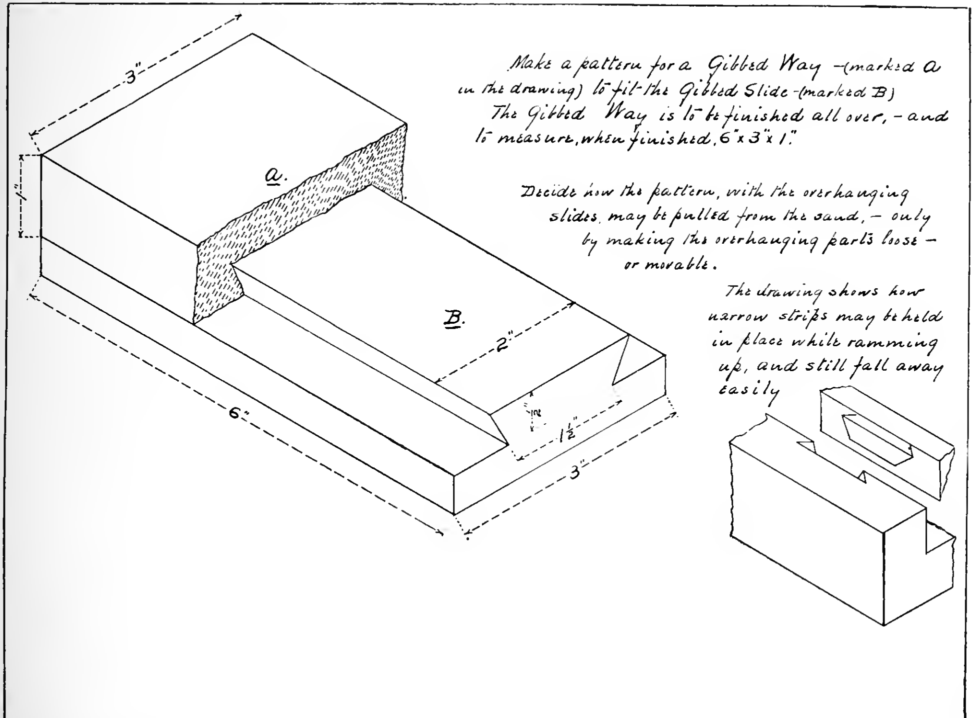

Make a pattern for a Gibbed Way —(marked A in the drawing) to fit the Gibbed Slide —(marked B)
The Gibbed Way is to be finished all over, — and to measure, when finished, 6" x 3" x 1".
Decide how the pattern, with the overhanging slides, may be pulled from the sand, — only by making the overhanging parts loose — or movable.
The drawing shows how narrow strips may be held in place while ramming up, and still fall away easily
3"
1"
A.
B.
2"
6"
1½"
3"

Fig. 327

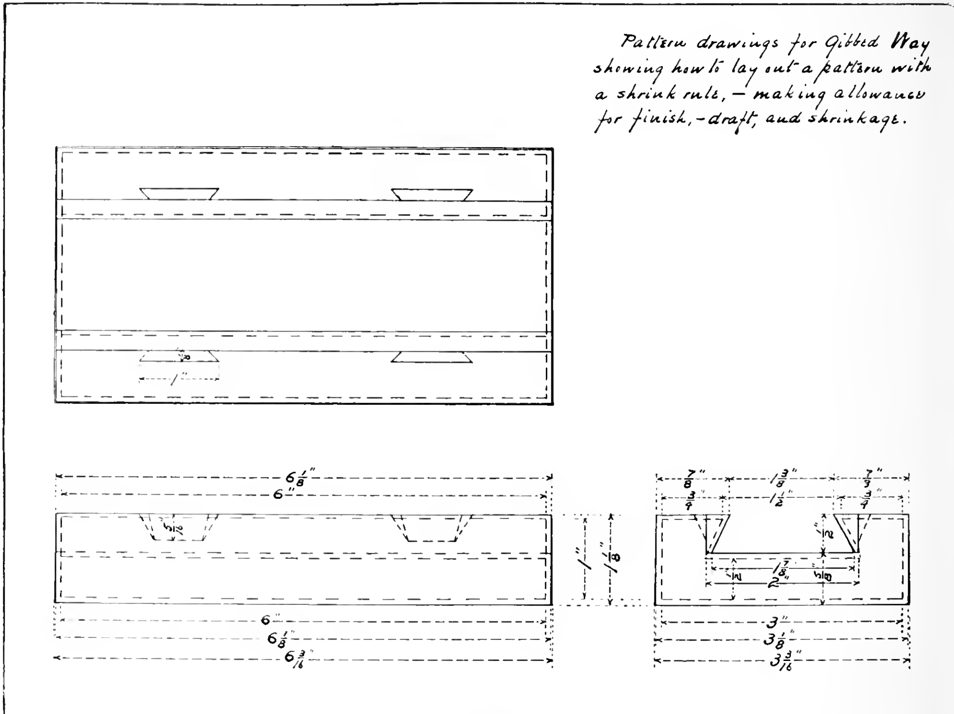

Pattern drawings for Gibbed Way showing how to lay out a pattern with a shrink rule, — making allowance for finish, — draft, and shrinkage.
1"
$6\frac{1}{8}$"
6"
$\frac{5}{16}$
1"
$1\frac{1}{8}$"
6"
$6\frac{1}{8}$"
$6\frac{3}{16}$"
$\frac{7}{8}$"
$1\frac{3}{8}$"
$\frac{7}{8}$"
$\frac{3}{4}$"
$1\frac{1}{2}$"
$\frac{3}{4}$"
$\frac{1}{2}$"
$1\frac{7}{8}$"
2"
$\frac{5}{8}$"
3"
$3\frac{1}{8}$"
$3\frac{3}{16}$"

FIG. 328

Study Fig. 329.

To make the pattern, plane the base of the pattern to the right thickness, $\frac{5}{8}$ in. Do not plane the edges or ends (see drawing A, Fig. 329).

Mark off a center line from end to end; measure off 1 in. on either side of the center line.

Plane narrow sticks—rectangular sticks—to $\frac{1}{2}$ in. thick; plane one edge also, the inside edge (do not plane outside edge).

Glue these sticks in place 2 ins. apart, on lines already found.

While glue is drying, plane to dimensions (except the length) the triangular sticks, and glue on small rectangular blocks, which are to make the small, dovetailed blocks. These small blocks may be chiseled into shape more easily when glued to the sticks. Mark off edges of pattern from the center line and plane to dimensions.

Varnish black, all over, with only one coat inside movable parts, that they may not stick.

Brass Bushing (Fig. 330)

Brass and bronze shrink, on cooling, $\frac{3}{16}$ in. to each foot.

This pattern is rammed up on end, and must have draft on vertical faces. The upper core-print must be loose, that the pattern may be rammed up on the follow-board, in the drag (the parting is the line A, B, Fig. 330). The core-print is then put in place, and rammed up in the cope.

This core-print must have much draft, that the core,

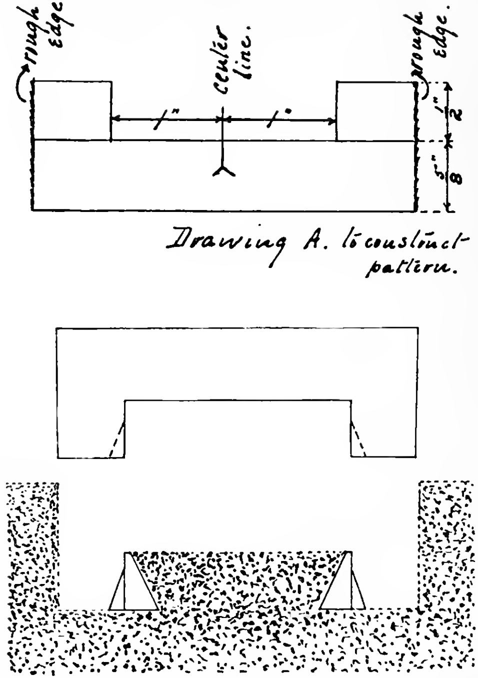


FIG. 329

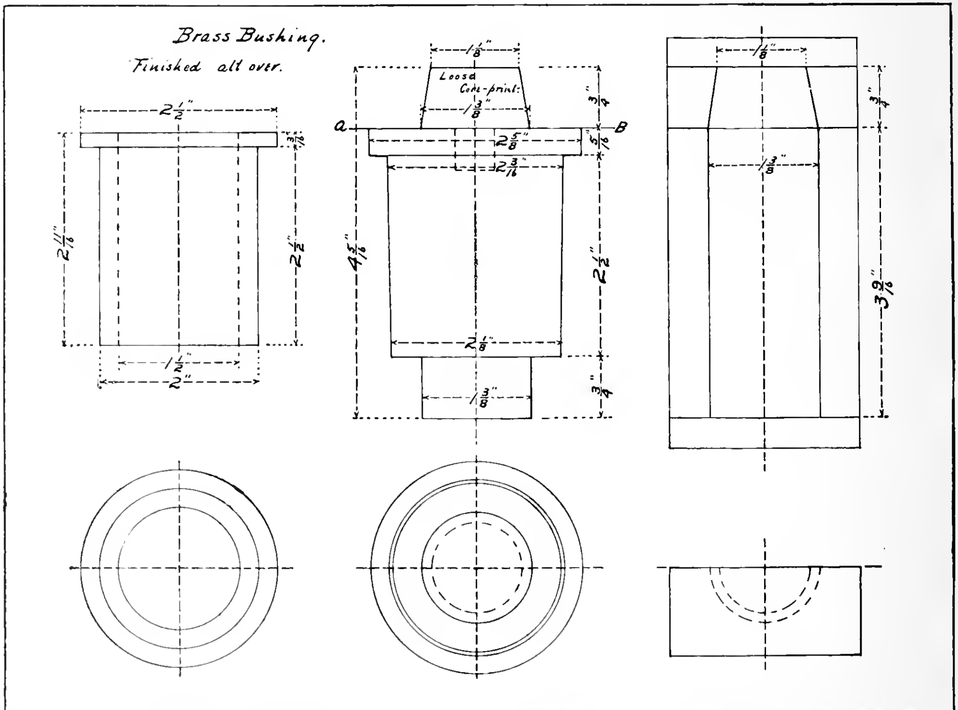


FIG. 330

when placed upright in the hole left by the lower core-print (which has no draft), if slightly out of the perpendicular, will swing into position by scraping against the sloping sides of the upper hole.

A small fillet should be turned under the rim, that the heavy metal may not have a sharp corner of sand to pour over, and carry particles of sand with it down into the mold.

Varnishing

Brass patterns are usually varnished red, with core-prints black or natural color.

The inside of the core-box (not the upper face of core-box) must be varnished same color as core-prints; the upper face like pattern.

This pattern may be made to "leave its own core"

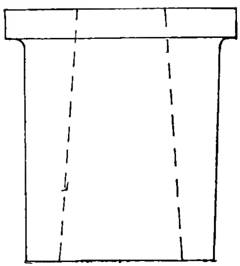


Fig. 331

by giving the hole a great amount of "reverse" draft (Fig. 331).

This method would be poor practice, in that the amount of draft must be so great in order that the pattern will pull easily, that much metal is wasted and also much time wasted in the machine shop, in boring out the hole.

To Make Semi-circular Core-boxes

True up block on face and ends, and gauge a center line.

With dividers, describe on each end a semi-circle of the required radius; connect the extremities of the two end arcs by straight lines on the face of the block (Fig. 332). Gouge out the core-box to the lines, using

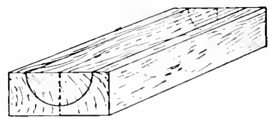


Fig. 332

the try-square as a templet to prove the half-circle, and if the block has been worked out to a perfect semi-circle, and the edges of the blades of the try-square or right-angled triangle touch the semi-circular curve at its extremities, the right angle or corner will touch the arc at every point (Fig. 333).

A core-box plane (Fig. 334) is constructed on this same principle, that if the sides of a right angle lie upon the extremities of a diameter of a circle, the vertex of the right angle will lie upon the circumference of the circle.

The plane-bit of the core-box plane is narrow and pointed, and may be pounded over to plane on one side, or the other, or in the center.

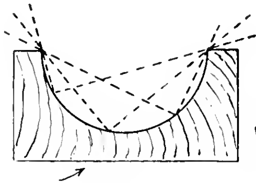


Fig. 333

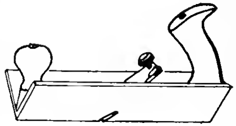


Fig. 334

To use the core-box plane, first mark off the block as shown (Fig. 335), connecting the two semi-circular arcs at either end by straight lines. Tack two very thin strips of hard wood along these lines, and on the outside, as shown. These strips serve to guide the plane, which is turned over on one side, the other lying against the strip. The plane-bit must be pounded over, so as not to cut the strip. Plane partly down one side, then pound the bit over and plane down the other until the heavier part of the work is done, down to the dotted line *a–b–c*, when the strips must be removed, and the core-box completed to a perfect half-circle. When making these finishing cuts, without the strips, care must be taken to adjust the plane-bit centrally, so that it will cut equally to both right and left; otherwise the work will not be correct.

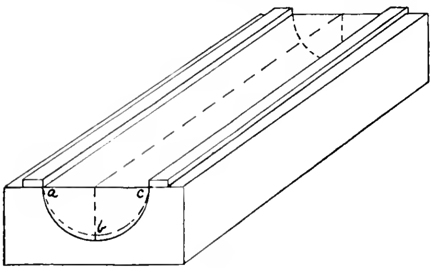


Fig. 335

The core-box must then be sandpapered, first with coarse, then with fine sandpaper held on a cylindrical block of a diameter slightly less than that of the core-box.

Tool Post (Fig. 336)

Finished all over, outside—hole unfinished. A Parted Pattern (Fig. 336)

This pattern is parted, that it may be taken from the sand easily.

One half the pattern is laid on the follow-board, rammed up, turned over (Fig. 337); the other half is laid on the first half—the dowels hold it in place—and rammed up in the cope.

When the cope is lifted away, the two parts of the pattern are easily removed from the sand.

If the pattern were made solid (Fig. 338) it would have to be rammed up entirely in the drag, and coped down

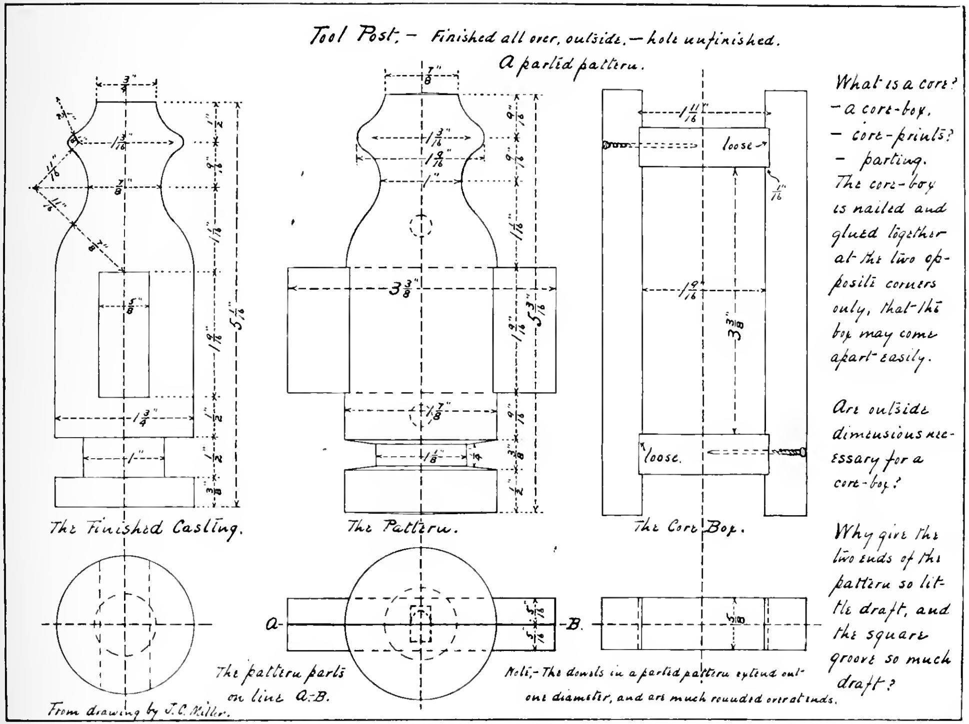

Tool Post; – Finished all over, outside. – hole unfinished.
A parted pattern.
What is a core?
– a core-box.
– core-prints?
– parting.
The core-box is nailed and glued together at the two opposite corners only, that the box may come apart easily.
Are outside dimensions necessary for a core-box?
Why give the two ends of the pattern so little draft, and the square groove so much draft?
loose
loose.
The Finished Casting.
The Pattern.
The Core Box.
The pattern parts on line A-B.
Note. – The dowels in a parted pattern extend out one diameter, and are much rounded over at ends.
From drawing by J. C. Miller.

FIG. 336

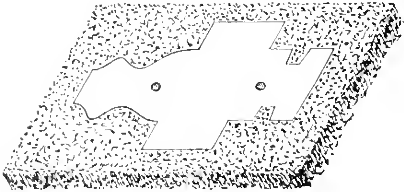


FIG. 337

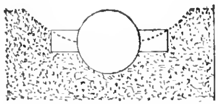


FIG. 338

to the center of the cylinder (see dotted lines on drawing) and to the top edge of the core-prints, making much extra work for the molder.

This casting has a rectangular hole through it. The dimension of the hole, one way, is so small, $\frac{5}{8}$ in., that it will be impossible to give enough draft to the sides to let the pattern "leave its own core." Then, too, the hole is unfinished, and if drafted so much, would be all out of true—not a rectangle—and time would be wasted in truing it up. So the hole must be "cored out"—that is, the metal must be made to pour around a smooth, rectangular brick, or shape, called a "core" (Fig. 339),

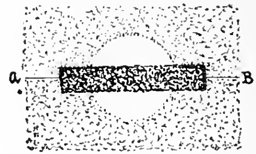


FIG. 339

made of core sand and flour and a little oil, baked in a hot oven.

This core is shaped in a "core-box" (Fig. 336).

If this core were made the exact size and shape of the hole, there would be no way of holding it in place, up in the center of the mold. So blocks, called "core-prints," are fastened to the pattern, at the exact position of the hole, the blocks becoming a part of the pattern, and leaving, like the pattern, their "prints" or shapes in the sand, which prints or shapes become a resting place for the core, the core being made long enough to extend clear across the round hole left by the round pattern and out into the rectangular holes left by the prints (see drawing, showing the baked core in place and the parting line a–B of the mold, Fig. 339).

Notice that the core fills up the holes left by the core-prints, so no metal runs into these holes.

Constructing a Parted Pattern

The stock must be long enough to glue a place at least $\frac{3}{4}$ in. long at the ends only (Fig. 340) and leave room

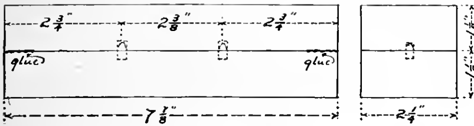


Fig. 340

for the pattern to be turned between these glued places.

Before gluing, two dowels must be glued in place; glued tight at one end and much rounded over at the other that the two parts of the pattern may come apart very easily.

In the tool-post, the core-prints are made of pieces $3\frac{3}{8}$ ins. long, and are let into each half of the pattern. In turning the pattern, find the positions of the two dowels on the cylinder, and lay out the position of the core-print between the two dowels, so that in cutting the groove for the core-prints, the dowels will not be cut away.

Do not cut the ends off the pattern in the lathe, or the two halves will fly apart. Saw off ends at your bench.

Varnish

Pattern, black, outside and inside; core-prints, red, outside and inside. Core-box red inside, black on top and bottom face only.

Wrenches (Fig. 342)

The handles for the wrenches are to be turned on the lathe with the live and dead centers in the positions shown.

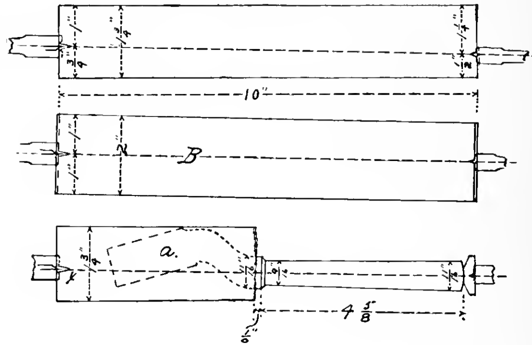


Fig. 341

Mark off on the $1\frac{3}{4}$ in. edge of wood the shape as at a (Fig. 341) and saw at band saw. Do not saw away the mark of the live center x, as it gives the position of the center line B on the new sawed faces.

Find the point on the center line, B, which is the center of the hexagonal head of the wrench, and lay out the two hexagons on either face. Bore a $\frac{3}{4}$ in. hole through the head and chisel.

Find the point on the center line, a (Fig. 343), which is the center of the hexagonal head of the wrench, and

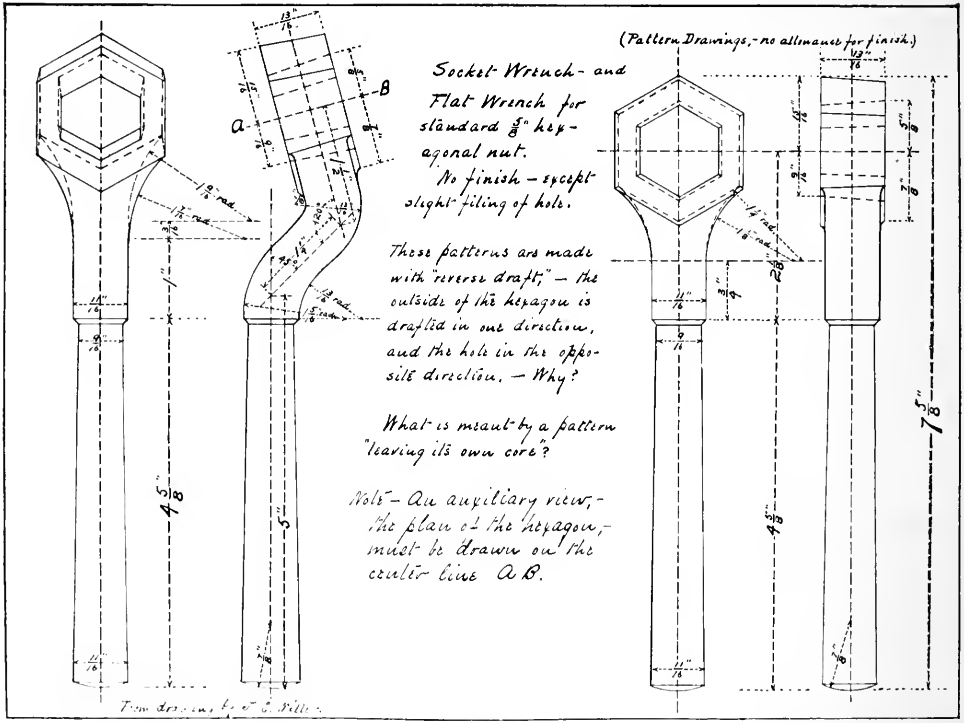

(Pattern Drawings, - no allowance for finish.)
Socket Wrench - and
Flat Wrench for
standard 5/8" hex-
agonal nut.
No finish - except
slight filing of hole.
These patterns are made
with "reverse draft," - the
outside of the hexagon is
drafted in one direction,
and the hole in the oppo-
site direction. - Why?
What is meant by a pattern
"leaving its own core"?
Note - An auxiliary view, -
the plan of the hexagon, -
must be drawn on the
center line A B.
From drawing by J. C. Miller.

FIG. 342

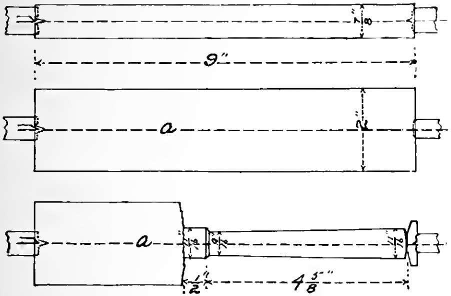


FIG. 343

lay out the two hexagons on either face. Bore a $\frac{3}{4}$ in. hole through the head, and chisel.

Varnish both wrenches black all over.

Turn Buckle (Fig. 344)

The ends of the turn buckle are to be tapped for $\frac{1}{2}$ in. diameter iron rods, and show only $\frac{5}{16}$ in. diameter core-prints, to allow for cutting the threads.

The core-prints are made $1\frac{3}{4}$ ins. long, the core-box $2\frac{3}{4}$ ins. long, for a special reason; the cores are unsupported at one end, extending out into the mold, but the greater length and weight of the supported ends lying in the openings made by the core-prints will keep the cores in place.

Such a core, extending out into the mold, and supported at one end only, is called a "balanced core."

The opening through the turn buckle will leave its own core, if coped down half way; the whole pattern will have to be coped down half way.

If many castings are to be made from this pattern, it should be parted along the line a–B (Fig. 344), to save the molder coping down each time the pattern is rammed up.

Another way to save the molder coping down, is to make the pattern solid—not parted—and to prepare for it a special follow-board (the follow-board is the board on which the pattern and the flask are laid while ramming up). The surface of the follow-board is carefully carved away, the pattern being let into, or sunk into, the board half way down. When the pattern is rammed up on such a board, turned over, and the board lifted off, half the pattern only is imbedded in the sand; the molder immediately rams up the cope without coping down, the follow-board having saved him that labor.

To Construct

Saw outside shape on band saw, bore two $\frac{5}{8}$ in. holes $1\frac{5}{16}$ ins. from either end, and saw inside curves with keyhole saw. The inside and outside edges are to be shaped to form the arc of a circle with $\frac{15}{16}$ in. radius.

Varnish pattern black, core-prints red, inside of core-box red, upper face only of core-box, black.

NOTE.—A $\frac{5}{16}$ in. dowel will make the core-prints.

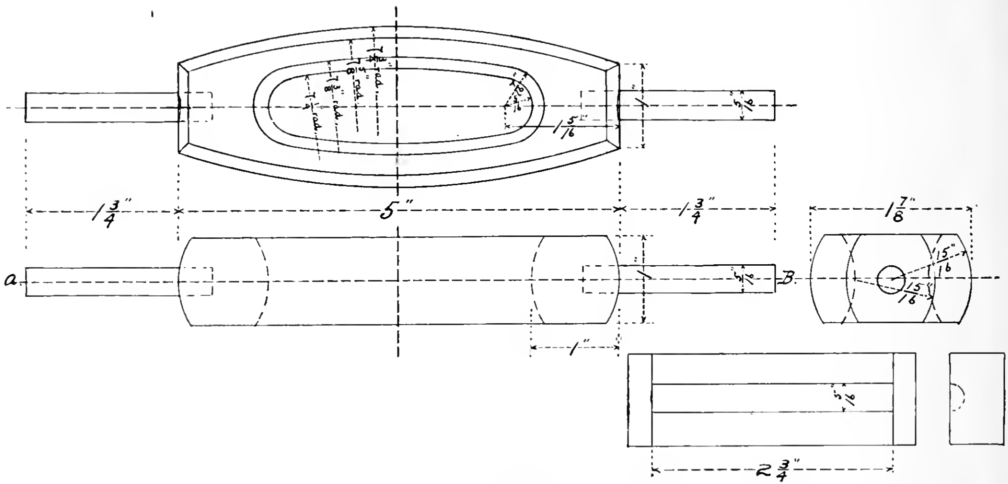


FIG. 344. Turn Buckle (Drawing of Pattern)

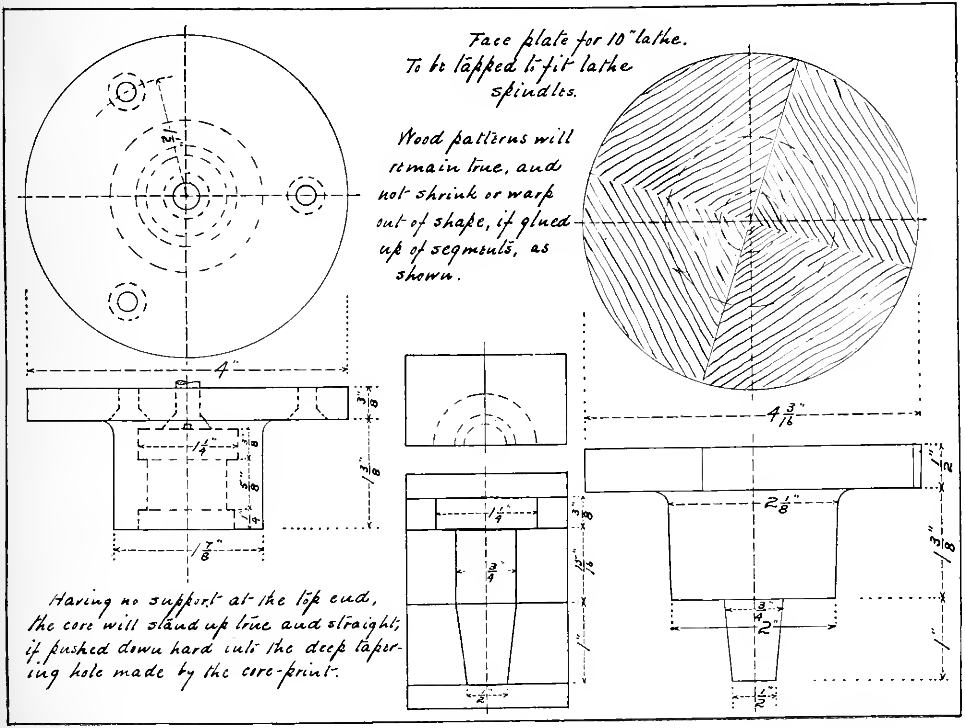

Face plate for 10" lathe.
To be lapped to fit lathe spindles.
Wood patterns will remain true, and not shrink or warp out of shape, if glued up of segments, as shown.
Having no support at the top end, the core will stand up true and straight; if pushed down hard into the deep tapering hole made by the core-print.
4"
3/8"
1 1/4"
5/8"
1/4"
1 3/8"
1 7/8"
1/2"
4 3/16"
1/2"
2 1/8"
1 3/8"
3/4"
2"
1"
13/16"

FIG. 345

Face Plate (Fig. 345)

Finished all over. Construction

Four or six segments may be used; six would be better if the pattern were larger, for fear of the shrinkage of the wood in the large segments.

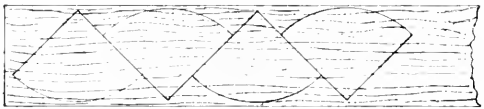


FIG. 346

Segments are laid out on a board, with dividers, the grain of the wood running as shown in Fig. 346.

It is easier to mark out and saw one segment to shape, and use it as a pattern to mark out the others.

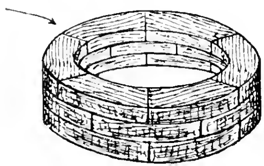


FIG. 347

In making a pattern for a pulley (Fig. 347) hexagonal segments are used to build up the rim, and the segments are so arranged that the joints in one layer are covered and strengthened by having the segments of the next layer directly over the joint.

In gluing up the stock to make the face-plate pattern, see that the segments are made of lumber thick enough to make also the fillet under the large face (Fig. 348, x).

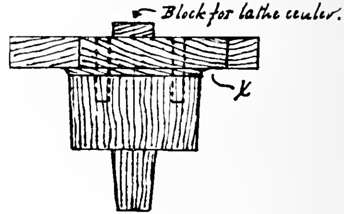


FIG. 348

The hub of the pattern and the core-print are turned from wood with the grain running the other way. The face made of segments should be fastened to the hub with two dowels and well glued.

The pattern is best turned between centers on the lathe, a small block being glued to the face to take the live center.

Only scraping tools must be used on the faces and edge of the part made of segments.

Varnish black, core-print red, inside core-box red, upper face only of core-box, black.

Chambered Block (Fig. 351)

Patterns for Square Bars of Cast Iron or Steel

Long bars of cast iron or steel are often required, also blocks of cast iron and steel. The patterns for these must have draft, if rammed up on any flat side, thereby making the casting out of square—untrue (Fig. 349).

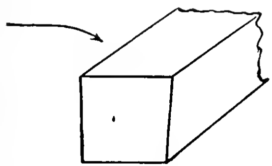


FIG. 349

Patterns for such castings should be parted diagonally (Fig. 350), as on the line a–B. No draft is required, excepting on ends, and the casting is square and true.

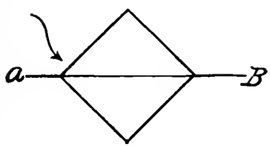


FIG. 350

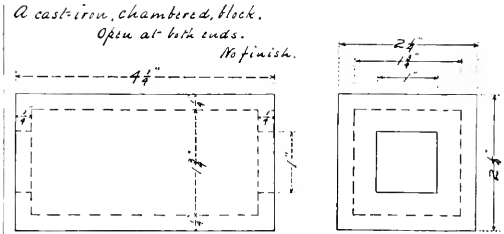


FIG. 351

Construction (Figs. 352, 353)

Glue together solidly a piece of $\frac{7}{8}$ in. thick and $1\frac{3}{4}$ in. thick pine.

Rip the piece lengthwise from end to end on one of its diagonals.

Plane the inside faces perfectly true, mark off center line lengthwise, glue in the dowels, as this is a parted pattern.

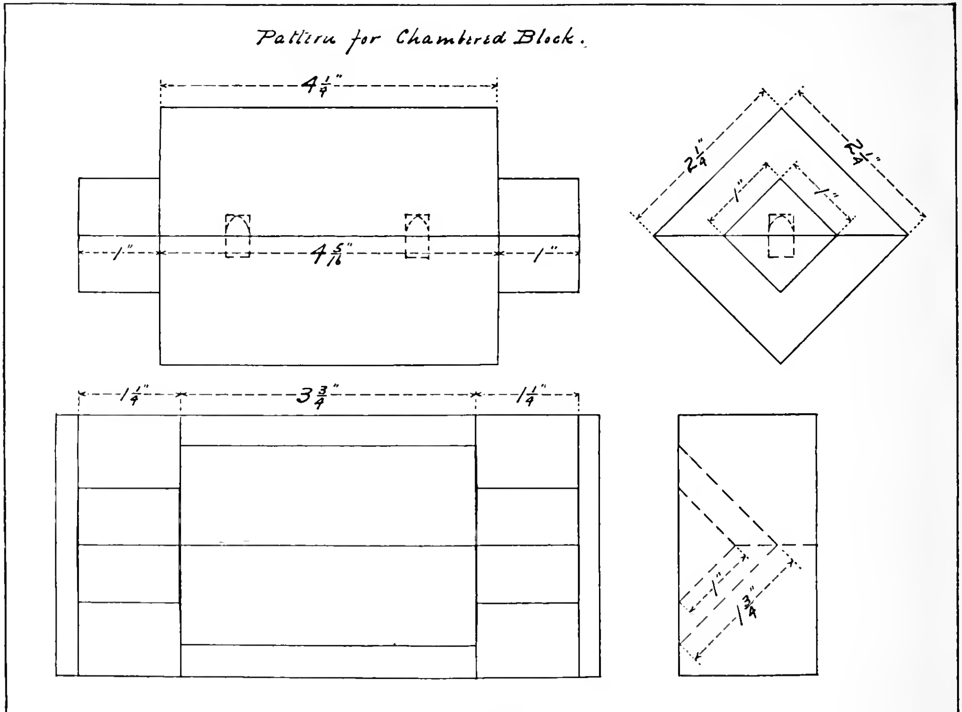
Set the bevel to 45° and mark off sides of the block from the inside faces.

Draft the ends clear to the parting (Fig. 352).

In making the core-box, plane up two pieces, beveling one edge of each to 45° and glue them together (Fig. 353).

Varnish pattern black, all over; core-prints red, inside of core-box red, upper face only of box, black.

The inside face of patterns—the parting—is sometimes varnished red and black to show the exact position of



Pattern for Chambered Block.
4 1/4"
1"
4 5/16"
1"
2 1/4"
2 1/4"
1"
1"
1 1/4"
3 3/4"
1 1/4"
1"
1 3/4"

FIG. 352

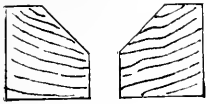


Fig. 353

the part cored out, which in this case would be the chamber and the open holes at the ends.

The core-prints on the pattern are 1 in. long only, while the corresponding parts of the core-box are $1\frac{1}{4}$ ins. long. Why?

Methods of Coring (Fig. 355)

To core a horizontal hole through a solid casting, core-prints are glued on to pull from the parting without coping down (Fig. 356). The core is placed in position, and the holes left by the prints filled up and smoothed over with green sand.

To core a recess in the edges of a casting, core-prints are added, large enough to overbalance the weight of the recess core (Fig. 356). In this case, in which the recesses are connected by a horizontal hole, the round core is filed to fit the recess cores, the three are fastened together, and slid down in place (Fig. 357).

Core-box for Recess Core

Since both recesses are the same size, one core-box will suffice (Fig. 354).

The core-box must be nailed and glued at the two opposite corners only, the other corners remaining loose.

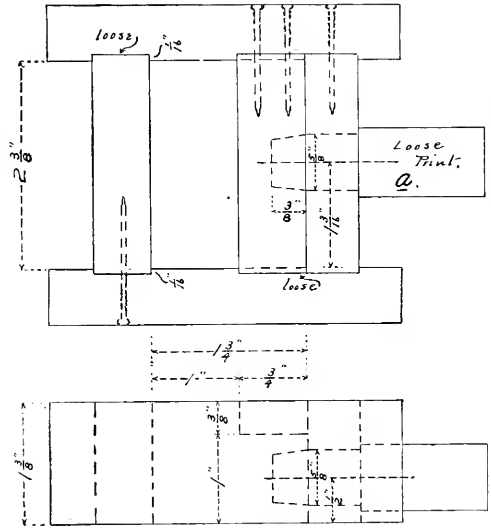


Fig. 354

The loose print, marked *a*, is to be in place until the core is made in the box, then carefully pulled out, leaving a print for the core of the connecting hole.

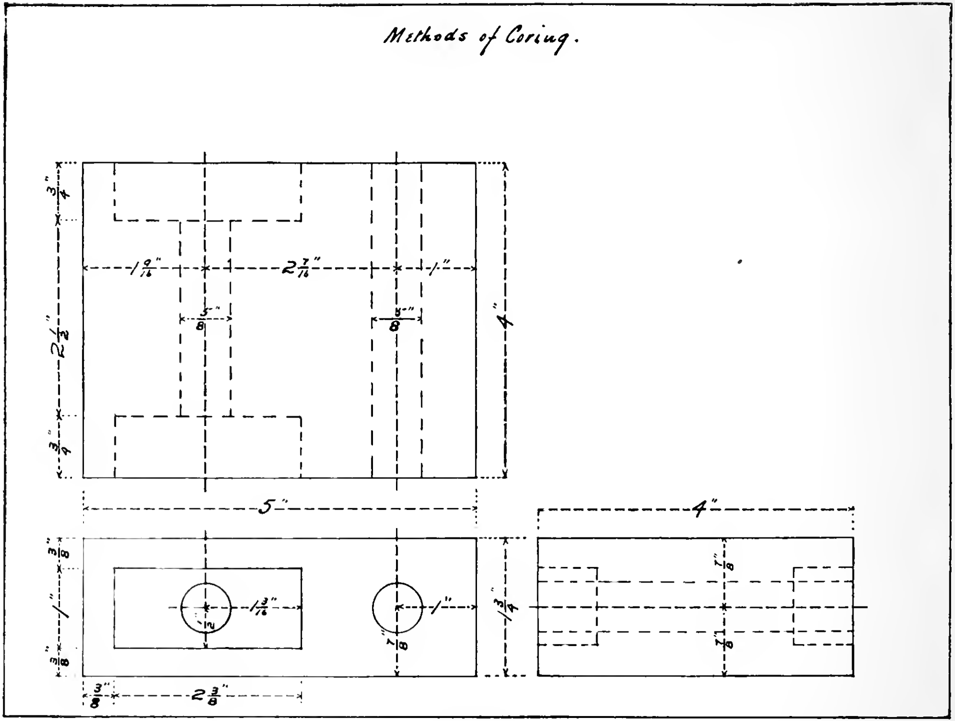

Methods of Coring.
3/4"
2 1/2"
3/4"
1 9/16"
2 7/16"
1"
5/8"
5/8"
4"
5"
4"
3/8"
1"
3/8"
1 3/16"
1/2
1"
7/8"
1 3/4"
7/8"
7/8"
3/8"
2 3/8"

Fig. 355

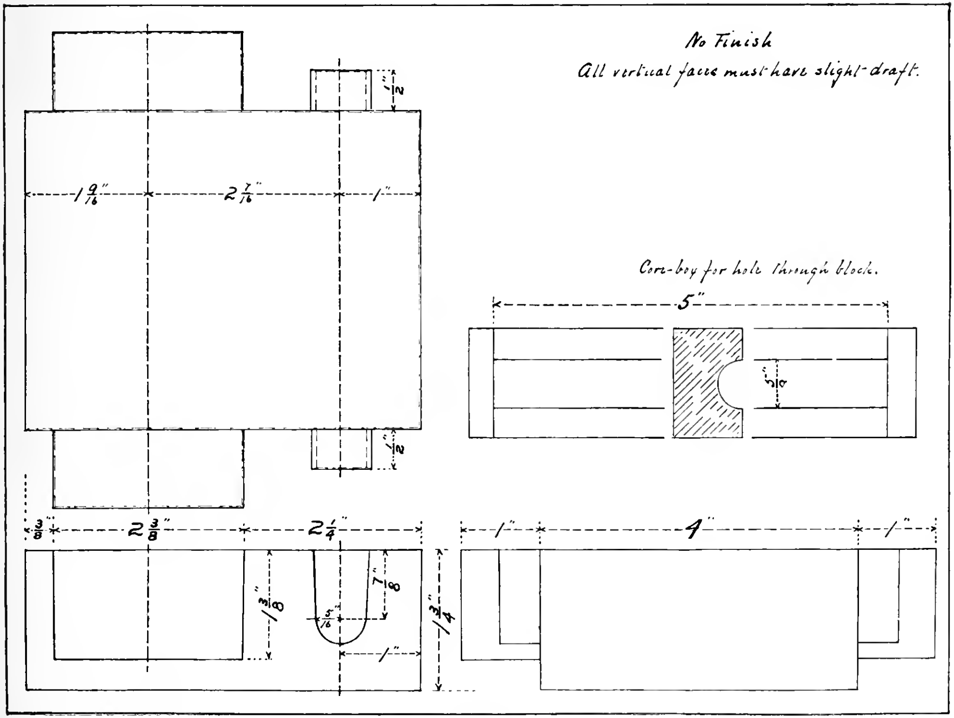

No Finish
All vertical faces must have slight draft.
Core-box for hole through block.
5"
5/16"
1/2"
1/2"
1 9/16"
2 7/16"
1"
3/8"
2 3/8"
2 1/4"
1"
4"
1"
1 3/8"
7/8"
5/16"
1"
1 3/4"

Fig. 356

This core is made in the other $\frac{5}{8}$ in. core-box shown, cut off to the right length, $3\frac{1}{4}$ ins., and the ends filed to fit the print in the cores. The three cores are then fastened together and slid down in place (Fig. 357).

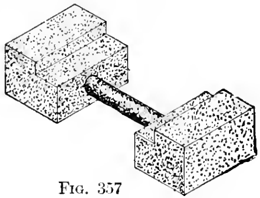


Fig. 357

Mark off center lines, and work to center lines throughout.

Varnish the inside of small core-box red, upper face only black; the inside of large core-box red, including the drafted end of loose print, *a;* the upper and lower faces of large core-box black; also hole to take loose print, *a;* and that part of the print which goes in the hole; pattern, black; core-prints, red.

Pipe Connections

A tee pipe connection for 1 in. pipe (Fig. 358).

The dimension, 1 in., is the diameter of the inside of the pipe. 1 in. pipe is about $\frac{5}{32}$ in. thick, making the outside diameter of the pipe $1\frac{5}{16}$ ins.

As the outside of the pipe is threaded to screw into the tee, the three ends of the tee are cored to $1\frac{1}{8}$ ins. diameter, allowing $\frac{1}{32}$ in. all around for reaming the holes true, and $\frac{1}{16}$ in. all around ($\frac{3}{16}$ in. in all) for the depth of the thread.

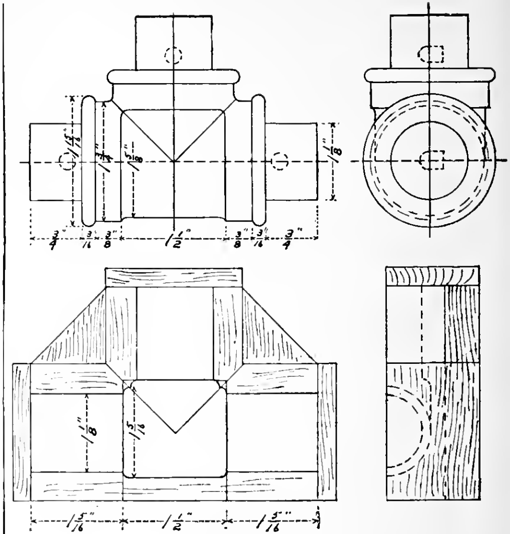


Fig. 358

The tee is chambered out in the inside to the full diameter of the outside of the pipe, $1\frac{5}{16}$ ins. (see core-box, Fig. 358).

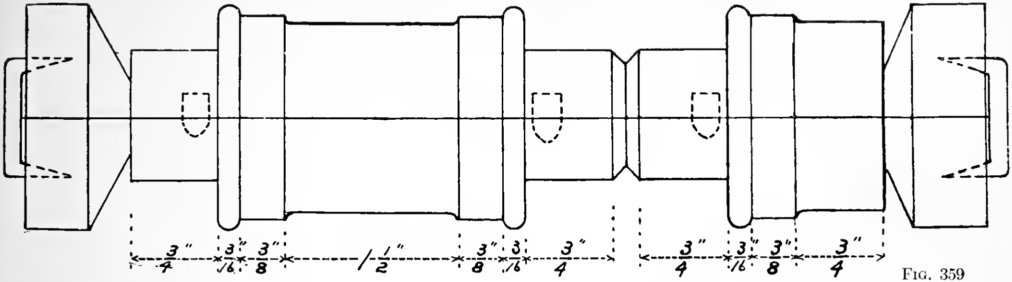


Fig. 359

To Construct

Tee patterns are easily made, as the entire pattern may be turned at one time (Fig. 359).

Staples or Dogs

Often there is no time to glue together the pieces forming a parted pattern, so after the dowels are spaced off and glued in, the two halves are held together by means of staples, driven in at the ends (Fig. 360).

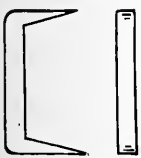


Fig. 360

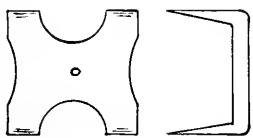


Fig. 361

These staples are so made that they bind more closely as they are driven in (Fig. 360).

For large patterns staples are even stronger and safer than glue, and are made in the form of a staple plate (Fig. 361).

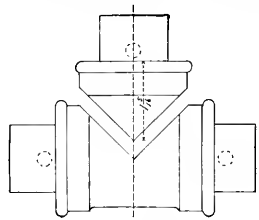


Fig. 362

The long part of the pattern is cut away, and the short piece mitered in (Fig. 362).

Varnish pattern black, core-prints red, inside core-box red, upper face only of core-box, black.

Elbow for 1" pipe

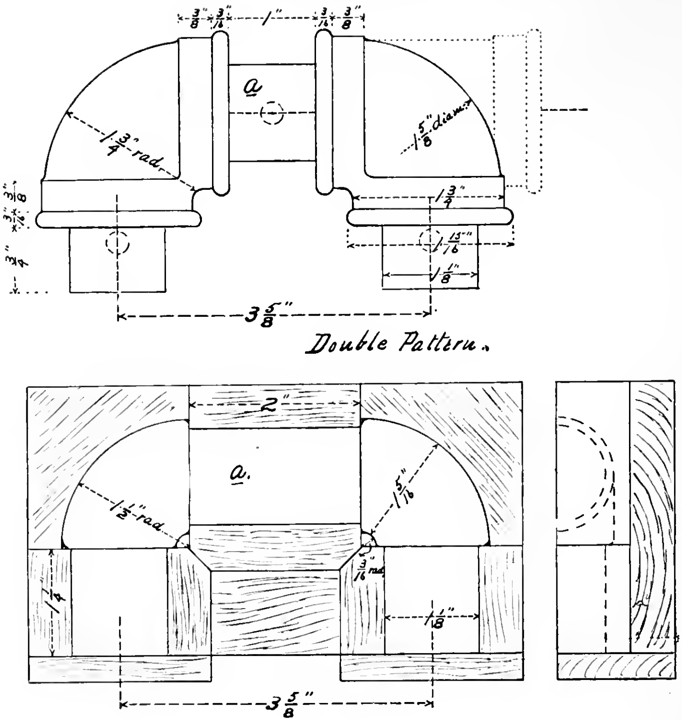


FIG. 363

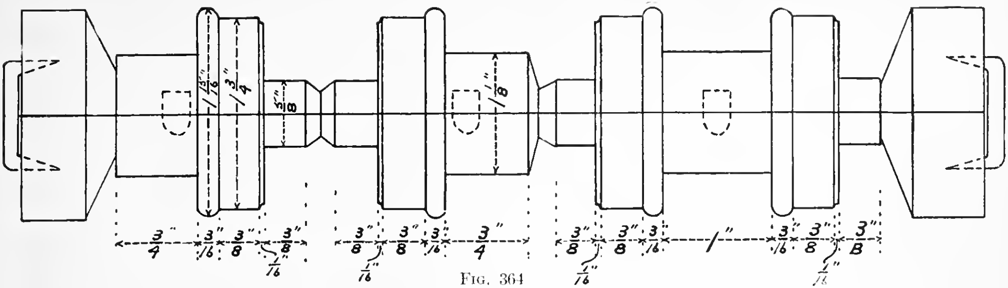


FIG. 364

Pipe Connections

Elbow for 1 in. pipe (Fig. 363).

Elbows and tees are so made, that if one is substituted for the other, the center lines, or the position and direction of the pipe, remain unchanged.

The patterns must be made on the same center lines (the tee is shown in dotted lines, Fig. 363).

A double pattern for the elbow is made that the core may not fall down at the turn. Very long core-prints would be necessary to keep the core in place, so, since elbows are cast in great numbers, a double pattern is made, the core being held up by the connecting part at A (Fig. 363).

Construction

After fitting and gluing in the dowels, turn the core-prints and end parts in one piece (Fig. 364); turn also a short dowel on ends, to be glued and screwed into turn.

The turn is to be glued up of four pieces with the grain running diagonally across the block, and screwed to a block of wood, fastened to the iron face plate of your lathe (Figs. 365, 366). After turning, saw the

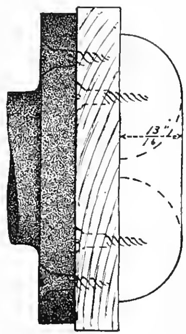


FIG. 365

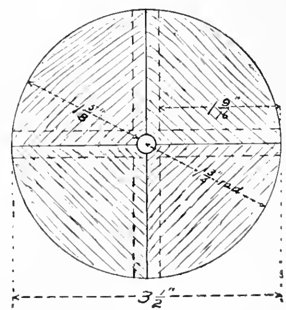


FIG. 366

turns to the dotted lines, clamp them together carefully, two and two, and bore for the $\frac{5}{8}$ in. dowel in the ends. These are then glued in place, and further strengthened by a small wood screw (Fig. 367).

The core-box is also turned from lumber glued up so that the grain runs diagonally across the block (Fig. 368).

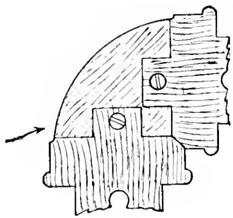


Fig. 367

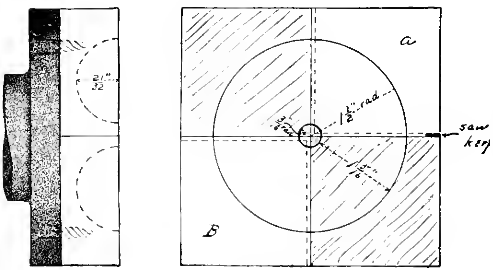


Fig. 368

As the turns of the core-box must be a perfect quarter circle, and as the parts A and B are not needed to make the core-box, the saw kerf is taken out of these parts.

After the straight parts of the box are worked out, and fitted and glued to the turns, the whole core-box is glued to a half-inch-thick block to strengthen it.

Varnish pattern black, core-prints red, inside core-box red, upper face only of core-box, black.

Pipe Connections

A double pattern for a return bend, for 1 in. pipe (Fig. 369).

This pattern is made double that one core will balance the other.

To Construct

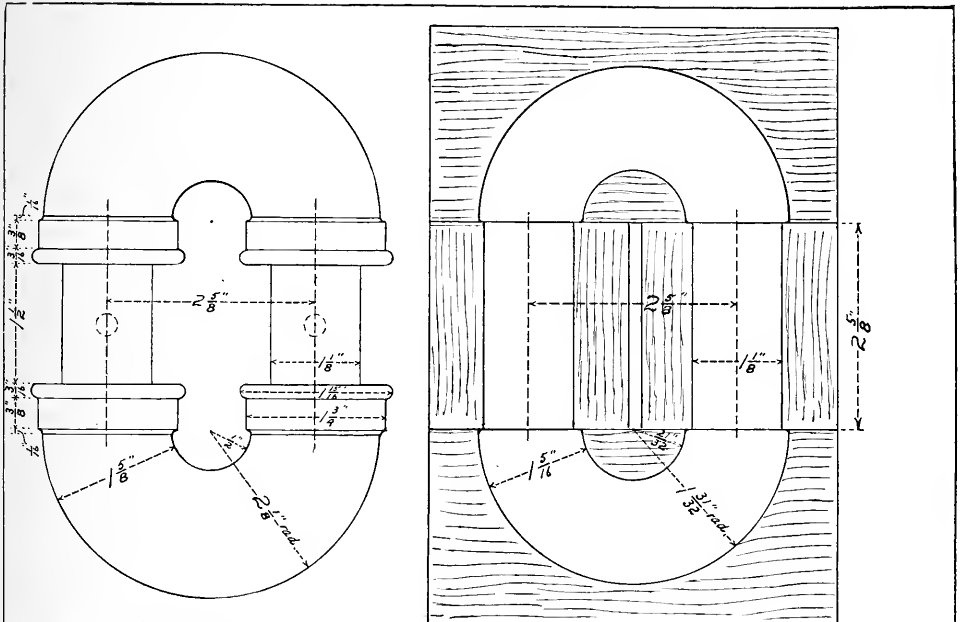
Turn core-prints, ends and dowels all in one piece (Fig. 370).

Since the whole half of the pattern is not required, the two blocks may be glued together to turn, and then sawed apart on the dotted lines, as shown.

Since the core-box requires the whole half of the circle, the two parts may be fastened together with staples instead of glue, while turning, care being taken to screw the blocks firmly to the face plate (Fig. 370).

The parts of the core-box, when fitted together, must be glued on a stiff board.

Varnish pattern black, core-prints red, inside core-box red, upper face only of core-box, black.



Pipe Connections. —
a double pattern for a return bend, — for 1" pipe.

Fig. 369

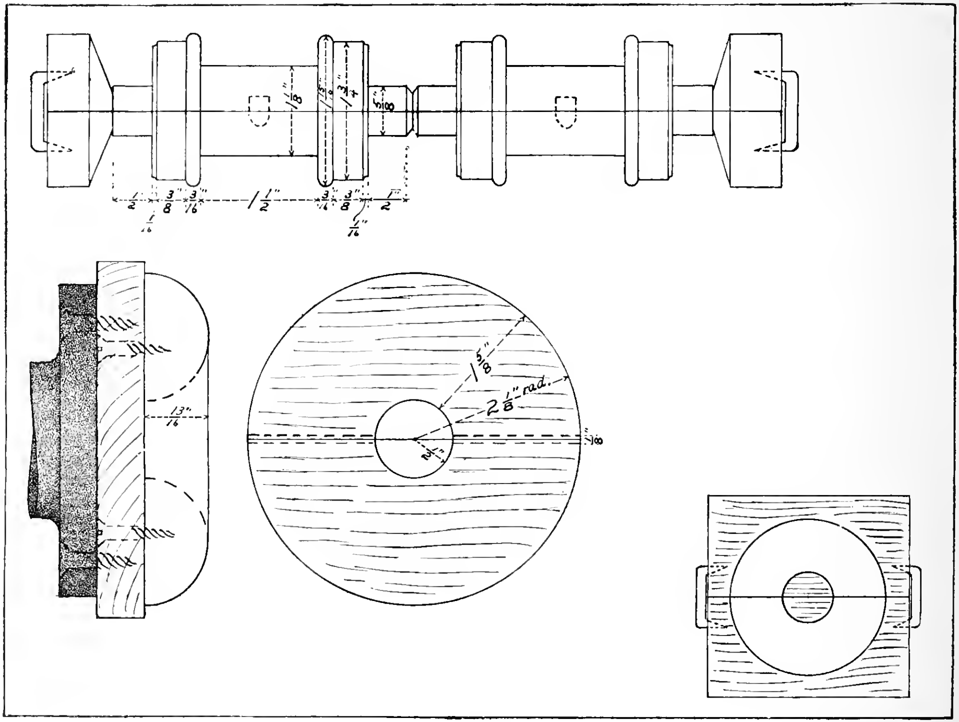


Fig. 370

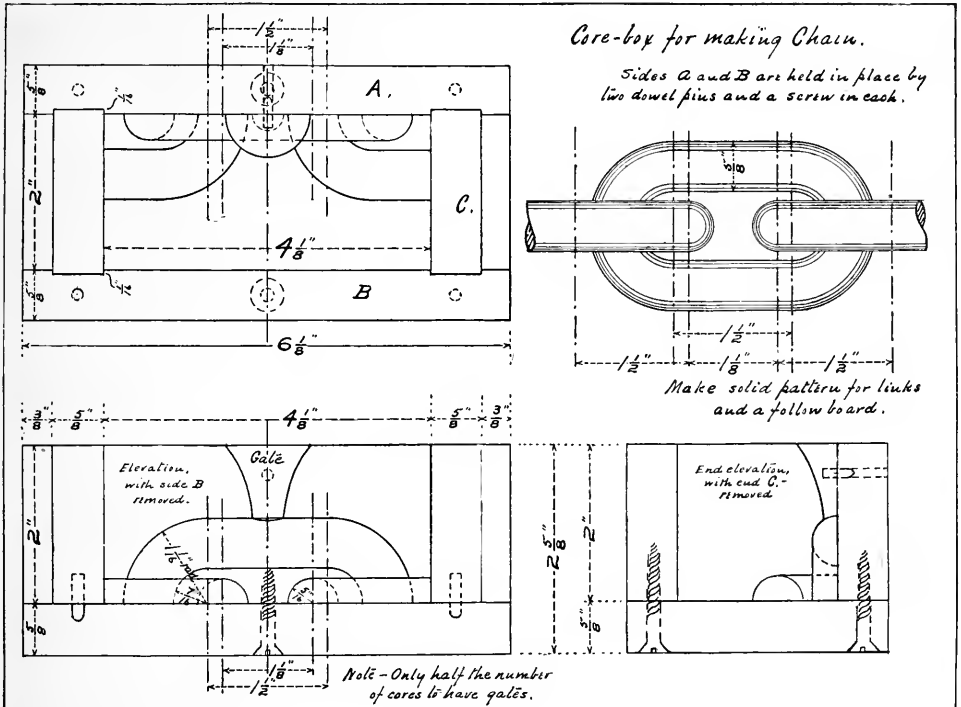

Core-box for making Chain.
Sides A and B are held in place by two dowel pins and a screw in each.
Make solid pattern for links and a follow board.
A.
B
C.
Elevation, with side B removed.
Gate
End elevation, with end C. removed
Note – Only half the number of cores to have gates.

FIG. 371

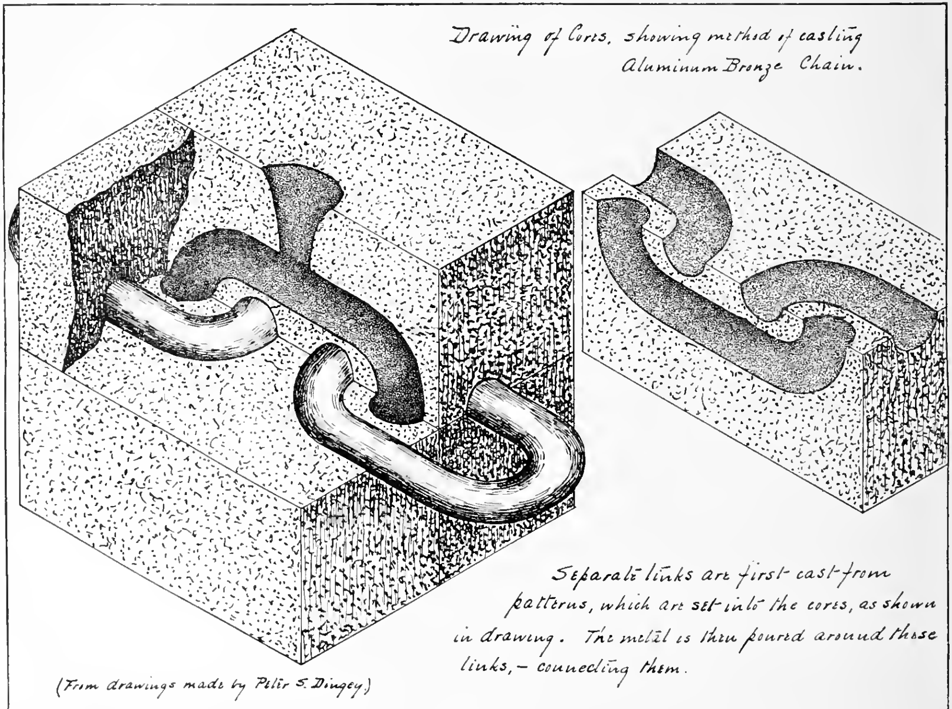

Drawing of Cores, showing method of casting
Aluminum Bronze Chain.
Separate links are first cast from patterns, which are set into the cores, as shown in drawing. The metal is then poured around these links, - connecting them.
(From drawings made by Peter S. Dingey.)

FIG. 372

SUGGESTIVE QUESTIONS

Pattern Making

1. What fine wood is generally used for patterns? Why?
   Should it be straight grained?
2. What is shrinkage, a flask, rappage, finish, draft, cope, drag or nowel, a shrink rule?
3. What is a mold?
4. Why is a mold divided?
5. Why is the pattern divided?
6. What name is given to the place of dividing the mold and pattern?
7. What is meant by draft on a pattern? Is the amount of draft always the same?
8. What further effort is made to have the pattern pull from the sand easily?
9. What is meant by finish on a pattern?
10. What is meant by shrinkage in metal?
    How is it allowed for in making a pattern?
11. How much allowance must be made on a pattern for shrinkage, when the casting is to be made of iron? Brass?
12. How may the allowance be accurately measured in making patterns?
    Describe carefully a shrink rule.
13. What is a rapping plate?
14. Make a sketch of a pattern, making allowance for draft, finish and shrinkage, the casting, when finished, to be $5\frac{1}{2}$x$3\frac{1}{2}$x$1\frac{1}{2}$ ins.
15. Explain how the pattern for the shifting fork might be rammed up if it was a solid pattern.
16. What are fillets? Explain why they are used.
17. Name three kinds of fillets, and tell where each may be used.
18. How are leather fillets glued and pressed in?
19. How is beeswax, when used as a fillet, pressed into place?
20. Explain carefully your reasons for drafting the pattern of the gibbed way toward the movable parts.
21. Give an example of a pattern in which the upper core-print is loose and has much draft. Give other examples.
22. Explain how a vertical core may be made to true itself, while the molder is placing on the cope.
23. Could the brass bushing be cast without a baked core? Would the method be good practice?
24. Explain carefully just how to lay out a block of wood for a half core-box.
25. Why will the try-square make a true templet for a perfect semi-circular core-box?
26. What is a core-box plane? Explain how to use it.
27. What is a parted pattern?
28. How prepare the wood for such a pattern?
29. Make a drawing for the core-box of the tool-post, and explain why it must come apart easily.
30. Explain how the tool-post pattern is rammed up, removed and the core laid in place.
31. Why is the core made so long?
32. Are outside dimensions necessary for a core-box?

33. What is meant by reverse draft?
34. What is meant by a pattern leaving its own core?
35. What is a balanced core?
36. Explain why the core-prints on the pattern for the turn buckle are so long.
37. Explain how a follow-board may be made to save the labor of coping down.
38. Name parts of machines, the patterns for which are always made in this way.
39. Why is it sometimes necessary to construct patterns in this way?
40. What is meant by gluing up a pattern in segments?
41. Make a sketch showing how the segments are laid out on a board, ready to saw.
42. Make a sketch showing two or three layers of segments in position for a pulley rim.
43. Why is the core-print on the face-plate pattern made tapering?
44. Why are patterns for long, square bars of iron or steel parted diagonally?
45. In the pattern (Figs. 355–356), why are the core-prints for the recesses made to extend out so far?
46. The diameter 1 in. or 2 ins., as applied to iron pipe, is the measurement of what part of the pipe?
47. How thick is 1 in. pipe, and why should the core-prints for the "tee" pattern be $1\frac{1}{8}$ ins. in diameter?
48. Explain the simple way in which patterns for pipe connections are made.
49. What are staples or dogs, and explain their use.
50. How are tees and elbows similar?
51. Why are double patterns of pipe connections made? Explain carefully.
52. Make a sketch showing how the "turn" in the pattern for the elbow is made.
53. How is the turn fastened to the end pieces?
54. Make a sketch showing how the core-box is made.
55. Why is the pattern for the "return bend" a double pattern?
56. Make a sketch showing how the pattern is turned.
57. How are the two halves for the core-box held together while turning? Why not glued?

HELPFUL SUGGESTIONS

A perfectly dry room for manual training or home work is necessary,—dry floors and dry walls, that the tools may not rust, and so become useless; and the wood of which the benches are made,—the doors, the drawers, the tail vises,—swell with the dampness and stick.

The lumber used must be kept in a dry, warm room to season, and to stay seasoned, or it will take up so much moisture as to make all work warp or shrink open at the joints.

Benches

Solid, heavy benches will be found more serviceable with a quick acting iron vise, when possible, and with a tail screw vise also. The tail screw vise is most necessary, holding the lumber at both ends, and enabling the worker to plane very thin boards true and smooth, as they lie on the flat, true, bench top.

Gluing up the top of bench of narrow strips of wood prevents all warping and cracking.

Drawer room, safely locked, should be provided for each boy for his work, in his own bench, thereby doing away with the cost of the unsightly lockers around the room, and the floor space occupied by them. The drawer serves to hold the individual edged tools—the plane-bits and chisels,—the boy's own tools, the keeping of which in perfect condition is his special pride and a good part of his training.

Avoid all amateur tools. Buy the best tools of standard make.

High grade tools are highly tempered, so provide a fine oil-stone with which to sharpen chisels and plane-bits; the usual stone provided is much too coarse.

The habit of running to the grindstone to grind every day or every other day should be stopped. Grind square, with not too long a bevel, and sharpen on oil-stone only, every day, before beginning work. One grinding should last from a month and a half to two months.

The short, tange, firmer chisels, with beveled edges, are more easily handled by small workers, the beveled edge enabling the pupil to chisel close up into corners or dovetails.

Motors and Machinery

If the manual training room is not too large, and there is no occasion for long shafting, the machines may be driven by directly connected motors, though this method has its disadvantages; the machines do not start so easily or quickly as those having a loose and tight pulley, and in the case of the band saw the instructor must start the electrically driven saw every time, or let it run continuously, as the younger pupils cannot be trusted to do this; while the saw with the old-fashioned tight and loose pulley, with its shifting lever, may be started and stopped by any one at will.

A pony planer or single surfacer is almost a necessity for the use of teachers in getting out material. There is nothing but manual labor for the pupil in planing a one-inch-thick board of hard wood—oak or sycamore—down to a half-inch or less, especially since the pupil has received many weeks' training in planing true surfaces in carpentry before beginning cabinet work.

The circular saw is of course part of the equipment for the use of teachers only.

The band saw and scroll saws are perfectly safe for the pupils to use, and their educational value as tools beyond question,—their simple mechanical construction and the association of the pupil with such simple power-driven machines—the necessity of curved work in the course,—in cabinet making and pattern making,—and the training in following the marked curved and straight lines with the saw.

Truing devices for grindstones enable the instructor to keep the stones perfectly true and perfectly sharp, thereby aiding the amateurs to keep their plane-bits and chisels in proper condition.

The shaving exhauster not only carries away the shavings, but the fine dust from the planer and the circular and band saws, keeping the air of the room quite pure and free from dust.

The turning shop should have one large motor to drive the main and line shafts, and each lathe have its countershaft with loose and tight pulleys,—easily controlled by the pupils.

Several grindstones with truing devices are necessary in this shop.

The convenient tool case at the end of each lathe contains drawers for the use of each pupil, serving to hold his work and his individual tools, also a tool drawer to hold the general tools and the shorter rests and face plates,—making each lathe complete in itself,—the pupil finding it unnecessary to leave his lathe to go to the tool room.

Tool Room Supplies

Hand screws should be greased with a mixture of equal parts of tallow and beeswax. To prepare the mixture, melt it in a tall tin can, immersed in boiling water (it is dangerous to melt the wax over a fire). Dip the screws in the hot mixture, and swab the nuts in the jaws with a cloth tied around a piece of dowel rod, and dipped in the grease. When the hand screws are put together again, any surplus wax may be saved by screwing up and unscrewing the hand screw once or twice, the wax collecting on the jaw.

Files

The round-edge 9 in. mill files are necessary to file the large teeth of the rip saws in the circular saw. The saw is liable to crack at the base of the teeth if filed with a square-edged file.

The 7 in. slim taper is a triangular file and is large enough to have its corners almost round, and so serves for the smaller teeth of the cross-cut circular saw. The

4 in. slim taper is necessary to file the fine teeth in the back saws, which the 7 in. file would almost cut away.

Belt Repairing

Wire lacing is preferable, holding better and longer than rawhide, and without the noise of the belt hooks. Belt hooks are most convenient when a heavy belt has to be repaired in a hurry.

Very fast running belts should be made endless, that is, cut 4 ins. or 6 ins. longer than necessary, the ends beveled down with a sharp plane, lapped over and glued together. Warm two short boards in the heating oven, apply the glue, tack the belt to one board, lay on the other, and screw together with hand screws.

Belt men merely rub the two ends together, without hand screws—a poor method for amateurs.

A good quality of belt grease or dressing is most necessary. A liquid dressing is preferable, as it makes the belt more pliable and soft, by soaking in, than a surface coating of stick dressing (belt dressing is also made in sticks, to be held against the belt while running).

The belt should be carefully cleaned by scraping with the sharp side of a chisel before applying the dressing. Brush the dressing on with a good brush evenly and not too thick. If possible do not use the belt for several hours after dressing, though small narrow belts may be used immediately.

Lumber

First, clear lumber is altogether economical, the waste on account of knots, sap, narrow boards, in the poorer grades, more than making up for the difference in cost. White pine stumpage may be ordered "first clear," and will be wide, clear lumber, but short in length—only 3 or 4 ft.—and costs but half or two-thirds regular length—14 to 16 ft.

The abbreviation s2s means smooth, or plane, or size two sides, making 1 in. thick lumber only $\frac{7}{8}$ in. thick; $1\frac{1}{4}$ in. lumber, $1\frac{1}{8}$ ins. thick; 2 in. lumber $1\frac{3}{4}$ ins. thick.

Finishing Wood

The educational value of a careful finishing (varnishing) of the cabinet work and pattern work is without question. As much care and energy and thoughtfulness and patience are required to apply the coats dexterously, to rub down, to polish the piece, as to make it. A beautiful piece or pattern, no matter how well made, is only half completed without the beautifying, preserving varnish or wax. The smooth coats on the pattern are as necessary to the preserving of the pattern as they are a help to the molder in getting the pattern out of the sand,—the unfinished exercise, in either case, is the exercise of no utility, because of its incompleteness.

If making the exercise is educational in a constructive way, preserving it and beautifying it are educational from a standpoint of completeness, utility and artistic influence.

Brushes, Varnish, Oils

The two quill, split quill pointed pencils (brushes) are made of soft camel's hair, incased in quills,—one

quill, two quills, three quills, according to size wanted, for use in varnishing patterns, as they flow a very smooth coat. A handle is made for these brushes by cutting the quills open at the top, inserting a small $\frac{1}{4}$ in. dowel 6 or 8 ins. long, and winding the quills to the dowel with a strong, light cord.

The artists' round bristle brushes are useful in gluing the silk to the paper, and the paper to the boxes, in lining the glove boxes.

Select the piano finish copal rubbing varnish by sample, trying several kinds on thin boards prepared for the purpose. A varnish that flows smoothly, has a good body, dries hard in thirty-six or forty-eight hours, will do; a quick drying varnish will crack soon, and a slow drying varnish takes too long for manual training work, though it lasts longer without cracking.

The pure grain alcohol shellac varnish must be delivered in glass bottles, with rubber corks, as the varnish corrodes tin cans and is soon discolored, and the alcohol evaporates through a cork stopper.

Wood alcohol shellac varnish is not worth buying. The orange shellac is the unbleached shellac, and when cut or dissolved by pure grain alcohol makes a dark yellow or brown shellac varnish, used to varnish patterns, being mixed with lamp black to make the black varnish, and with Chinese vermilion, to make the red varnish for the core-prints and core-boxes.

Beeswax, aside from its use with tallow to wax or grease hand screws, is much used in pattern work for fillets—(filling corners). Apply it by pressing it into the corners with a carving chisel or gouge heated in hot water. Tin cups are very convenient for varnish cups, since they are so cheap that they may be thrown away when the varnish collects on the sides—or they are no longer needed. Cleaning varnish cups is costly economy when the cost of alcohol or turpentine is considered.

Glass bottles with rubber stoppers are required to hold the spirit stains—alcohol and red sanders; the oil stains—the diluted bichromate and water; alcohol and turpentine, supplies of which must be kept at the varnish table.

Varnish cans incased in wood are not likely to be punctured or bent, and will last for years.

Wood filler and wax are ordered in one or two pound cans because they both dry out if not used soon after opening, though the cans recently delivered have removable tin covers, which are air-tight.

Glue should be soaked overnight, just covered with water or less. Great quantities of glue should not be cooked at one time, but rather small quantities, and the pots kept clean by scraping off the old glue around the edges.

Heating or warming oven.—A coil of pipes heated with steam and covered with a large box having a convenient door is a most necessary part of the outfit for a woodshop or any factory where gluing is done.

All wood, ready to glue, should be heated or warmed slightly, in order that the glue may not chill and lie in a thick coating between the two pieces, but may enter well up into the pores of the wood.

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